S. Hrg. 102-165

DEPARTMENT OF ENERGY CRITICAL TECHNOLOGIES OF 1991

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDRED SECOND CONGRESS

FIRST SESSION

ON

S. 979

TO PROVIDE FOR STRONG DEPARTMENT OF ENERGY SUPPORT OF RESEARCH AND DEVELOPMENT OF TECHNOLOGIES IDENTIFIED IN THE MOST RECENT NATIONAL CRITICAL TECHNOLOGIES REPORT AS CRITICAL TO UNITED STATES ECONOMIC PROSPERITY AND NATIONAL SECURITY, AND FOR OTHER PURPOSES

JUNE 27, 1991

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Committee on Energy and Natural Resources

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DEPARTMENT OF ENERGY CRITICAL TECHNOLOGIES OF 1991

THURSDAY, JUNE 27, 1991

U.S. SENATE,
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The subcommittee met, pursuant to notice, at 2:05 p.m., in room SD-366, Dirksen Senate Office Building, Hon. Richard C. Shelby, presiding.

OPENING STATEMENT OF HON. RICHARD C. SHELBY, U.S. SENATOR FROM ALABAMA

Senator SHELBY. Good afternoon. I would like to first thank Senator Ford for scheduling this hearing. This is an important hearing not only for the Senate, but especially for this committee.

I believe the ability of this country tc compete in the international arena is in the news practically every day of our lives. Many bills have been introduced this session to increase and better coordinate the efforts of the Federal Government to develop technologies that will help the competitiveness of U.S. industry.

The bill that is the subject of today's hearing calls for increased Department of Energy support through its national laboratories for technologies that will help American industry compete. I want to commend Senator Bingaman, my colleague, for having introduced this legislation.

The Department of Energy and its national laboratories already carry out extensive research in many different technologies. They have not historically worked with industry to develop applied technology, but rather have concentrated on basic research. Some people believe that the laboratories should work with industry to develop technologies that are more directly relevant to industry.

I look forward to hearing from the witnesses this afternoon as to the laboratories' ability to help develop these technologies and what the proper role of the laboratories should be.

[The prepared statements of Senators Ford and Shelby and the text of S. 979 follow:]

PREPARED STATEMENT OF HON. WENDELL H. FORD, U.S. SENATOR FROM KENTUCKY

Good afternoon. Today, we will receive testimony on S. 979, the "Department of Energy Critical Technologies of 1991" which was introduced by our distinguished colleague from New Mexico, Senator Bingaman.

This bill speaks of critical technologies. The bill refers to a list of technologies labeled as critical—critical to the U.S. economy and national security.

It used to be that this country didn't have to worry about what technologies were critical. It didn't matter because we were the experts in all of the technologies. This is no longer the case. We no longer lead in the development and use of many technologies. Not only do we not lead, we follow.

Today, we are making lists of critical technologies because other countries are gaining on us. Some are even beating the United States. These technologies have become critical because the United States has become vulnerable to other countries. We are vulnerable both from an economic standpoint and a military standpoint.

The Department of Energy—through its national laboratories—has a big role to play in developing technologies important to industry and national security. The laboratories have unique capabilities that go far beyond those needed just for weapons or energy research.

The labs can contribute significantly to U.S. competitiveness. There are vast resources and expertise at the labs that can help us regain the leading role in technology. We have not focused enough on this in the past. I believe that the laboratories should cooperate more with industry in developing technologies that help the United States.

Because of a previous commitment I have this afternoon I will be unable to chair the hearing. So, I have asked Senator Shelby who is vice chairman of this subcommittee to chair this hearing.

Prepared Statement of Hon. Richard C. Shelby, U.S. Senator From Alabama

Good afternoon. Today, we will receive testimony on S. 979, the "Department of Energy Critical Technologies of 1991". The bill would increase the level of Department of Energy support for technologies important to the United States economy and national security. This bill was introduced by our distinguished colleague from New Mexico, Senator Bingaman.

Unfortunately, Senator Ford is unable to chair this afternoon's hearing. He has asked me to chair this important hearing.

The ability of this country to compete in the international arena is in the news practically everyday. Many bills have been introduced this session to increase and better coordinate the efforts of the federal government to develop technologies that will help the competitiveness of U.S. industry.

The bill that is the subject of today's hearing calls for increased Department of Energy support, through its national laboratories, for technologies that will help American industry compete. I commend Senator Bingaman for having introduced this legislation.

The Department of Energy and its national laboratories already carry out extensive research in many different technologies. They have not historically worked with industry to develop applied technology, but rather have concentrated on basic research. Some believe that the laboratories should work with industry to develop technologies that are more directly relevant to industry.

I look forward to hearing from the witnesses as to the laboratories ability to help develop these technologies and what the proper role of the laboratories should be.

II

102D CONGRESS
1ST SESSION

S. 979

To provide for strong Department of Energy support of research and development of technologies identified in the most recent National Critical Technologies Report as critical to United States economic prosperity and national security, and for other purposes.

IN THE SENATE OF THE UNITED STATES

APRIL 25, 1991

Mr. BINGAMAN (for himself, Mr. JOHNSTON, and Mr. DOMENICI) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

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A BILL

To provide for strong Department of Energy support of research and development of technologies identified in the most recent National Critical Technologies Report as critical to United States economic prosperity and national security, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be referred to as the "Department of Energy Critical Technologies of 1991".

SEC. 2. FINDINGS.

The Congress makes the following findings:

(1) It is essential that the United States maintain a world leadership position in the development and application of technologies that are critical to national security and economic prosperity.

(2) The Department of Energy laboratories have wide-ranging and unique capabilities in those technologies.

(3) It is in the national interest that those capabilities continue to be fully utilized to enhance United States national security interests and economic competitiveness.

(4) Increased interaction between Department of Energy laboratories and United States firms concerning research and development in critical technologies is necessary because of the increasing concurrency between commercial requirements in critical technologies and military requirements in critical technologies that is reflected in the most recent National Critical Technologies Report, the most recent Defense Critical Technologies Plan, and the most recent Emerging Technologies Report.

SEC. 3. PURPOSES.

The purposes of this Act are as follows:

(1) To provide for the coordination of the research and development activities of Department of

Energy laboratories in support of critical national security objectives (including energy security objectives) and economic competitiveness.

(2) To require the Secretary of Energy to develop a Department of Energy critical technologies plan that is supportive of research and development in critical technologies listed in the National Critical Technologies Report and to coordinate the implementation of such plan.

(3) To encourage and enhance the commercialization of the results of Department of Energy research and development in critical technologies.

SEC. 4. DEFINITIONS.

In this Act:

(1) The term "Department of Energy laboratory" means a single-purpose national laboratory of the Department of Energy and a multi-purpose national laboratory of the Department of Energy.

(2) The term "Department of Energy critical technology" means a critical technology, identified in the most recent National Critical Technologies Report, with respect to which a Department of Energy laboratory has demonstrated a broad technological competence, as determined by the Secretary of Energy.

(3) The term "National Critical Technologies Report" means the biennial report on national critical technologies submitted to Congress by the President pursuant to section 603(d) of the National Science and Technology Policy, Organization, and Priorities Act of 1976 (42 U.S.C. 6683(d)).

(4) The term "Defense Critical Technologies Plan" means the annual defense critical technologies plan submitted to Congress by the Secretary of Defense pursuant to section 2508 of title 10, United States Code.

(5) The term "Emerging Technologies Report" means the Emerging Technologies Report published by the Department of Commerce.

(6) The terms "Critical Technologies Planning Council" and "Council" each mean the Critical Technologies Planning Council established pursuant to section 101(a).

(7) The terms "Critical Technologies Advisory Board" and "Advisory Board" each mean the Critical Technologies Advisory Board established pursuant to section 102.

(8) The terms "Department of Energy Critical Technologies Plan" and "Plan" each mean the De-

partment of Energy Critical Technologies Plan referred to in section 103(a).

(9) The terms "Department of Energy Critical Technology Partnership" and "Partnership" each mean a Department of Energy Critical Technology Partnership established pursuant to title II of this Act, or any similar partnership established by the Secretary of Energy to enhance the development and utilization of Department of Energy critical technologies.

(10) The term "United States firm" means a company or other business entity that—

(A) conducts, in the United States, significant research, development, engineering, and manufacturing activities relating to Department of Energy critical technologies;

(B) makes significant contributions to employment in the United States; and

(C) is a company or other business entity the majority ownership or control of which is in United States citizens or is a company or other business entity that is owned by a parent company that is incorporated in a country the government of which—

(i) encourages the participation of United States owned firms in research and development consortia to which the government of that country provides funding directly or indirectly through international organizations; and

(ii) affords adequate and effective protection for the intellectual property rights of companies incorporated in the United States.

(11) The term "core competency", with respect to a Department of Energy laboratory, means a research and development capability relevant to Department of Energy critical technologies which the laboratory regards as central to the ability of the laboratory to carry out its missions and for which the laboratory has developed extensive and unique capabilities.

TITLE I—DEPARTMENT OF ENERGY CRITICAL TECHNOLOGIES PROGRAM

SEC. 101. DEPARTMENT OF ENERGY CRITICAL TECHNOLOGIES COUNCIL.

(a) ESTABLISHMENT.—The Secretary of Energy shall establish within the Department of Energy a council to be known as the "Critical Technologies Planning Council".

(b) COMPOSITION.—The Council shall be composed of the following officers and employees of the Department of Energy:

(1) The Under Secretary of Energy.

(2) The Director of the Office of Waste Management and Environmental Restoration.

(3) The Director of the Office of Energy Research.

(4) The Assistant Secretary of Energy for Defense Programs.

(5) At least one representative from each of the Department of Energy laboratories.

(6) Any additional officers and employees of the Department of Energy that the Secretary of Energy designates as a member of the Council.

(c) CHAIRMAN.—The Under Secretary of Energy shall be the Chairman of the Council.

(d) DUTIES.—The Council shall—

(1) serve as the lead organization within the Department of Energy responsible for the development of the Department of Energy Critical Technologies Plan;

(2) coordinate the activities of the Department of Energy laboratories carried out under the program provided for in the Plan;

(3) consult with the Critical Technologies Advisory Board and coordinate with other appropriate departments and agencies of the Federal Government, State entities, United States firms, academic groups, and other appropriate groups regarding the implementation of the Plan to the extent the Council considers appropriate;

(4) serve as a point of contact within the Department of Energy for the encouragement of international cooperative scientific and technological activities of government scientists, scientists in United States firms, and university scientists in matters relevant to research and development in Department of Energy critical technologies; and

(5) each year, before the submission of the budget to Congress pursuant to section 1105 of title 31, United States Code, review the budget for consistency with the Plan and transmit the results of that review to the Secretary of Energy.

SEC. 102. DEPARTMENT OF ENERGY CRITICAL TECHNOLOGIES ADVISORY BOARD.

(a) ESTABLISHMENT.—The Secretary of Energy shall establish within the Department of Energy a Board to be known as the "Critical Technologies Advisory Board".

(b) COMPOSITION.—The Advisory Board shall be composed of persons selected for the Advisory Board from among the members of the Secretary of Energy Advisory Board (SEAB).

(c) DUTIES.—The Advisory Board shall provide the Secretary of Energy and the Council with advice and information on Department of Energy critical technologies, including a periodic assessment of—

(1) the Department of Energy Critical Technologies Plan;

(2) the progress made in implementing the Plan;

(3) any need to revise the Plan;

(4) the balance between the components of the Plan; and

(5) other issues related to the Plan as identified by the Secretary.

SEC. 103. DEPARTMENT OF ENERGY CRITICAL TECHNOLOGIES PLAN.

(a) REQUIREMENT FOR PLAN.—The Secretary of Energy shall develop, once every two years, and implement a five-year Department of Energy Critical Technologies Plan that—

(1) coordinates the individual and interactive research and development activities of the Department of Energy laboratories in support of research and development in Department of Energy critical technologies; and

(2) provides for the coordination of the Department of Energy Critical Technologies Partnerships.

(b) SUBMISSION OF PLAN TO CONGRESS.—The Secretary shall submit each Plan to Congress.

(c) CONTENT OF PLAN.—The Plan shall include the following:

(1) Goals and priorities, established in close consultation between the Council and United States firms, for a Department of Energy critical technologies program to be conducted for the five fiscal years following the fiscal year in which the Plan is submitted to Congress.

(2) A specific identification of the programs and activities of the Department of Energy laboratories that are relevant to research and development in

Department of Energy critical technologies, the specific goals and objectives of such programs and activities, and a summary of the recommended budget for such programs and activities at each laboratory for the five fiscal years covered by the Plan.

(3) Procedures for coordinating the Department of Energy critical technologies activities of the Department of Energy laboratories.

(4) Procedures for facilitating collaboration between the Department of Energy laboratories and other departments and agencies of the Federal Government on common interests and expertise associated with Department of Energy critical technologies.

(5) Procedures for facilitating international cooperative activities of government, United States firms, and university scientists relating to Department of Energy critical technologies.

(6) A discussion of the research and development activities conducted by Department of Energy laboratories in Department of Energy critical technologies during the two fiscal years preceding the fiscal year in which the Plan is submitted to Congress, including an analysis of the progress made toward achieving the goals and objectives of the Plan (as in effect during such fiscal years) and a summa-

ry of Department of Energy budgets for research and development in Department of Energy critical technologies for such fiscal years.

(d) DEPARTMENT OF ENERGY LABORATORY CORE COMPETENCIES REPORTS.—(1) Once every two years the head of each Department of Energy laboratory shall submit to the Critical Technologies Planning Council and the Critical Technologies Advisory Board a report on the core competencies of such laboratory. The report shall identify the national critical technologies listed in the most recent National Critical Technologies Report published before the date of such report for which such laboratory has developed core competencies.

(2) The report of a Department of Energy laboratory shall contain, at a minimum, the following:

(A) A description of each laboratory program of research and development in the critical technologies identified in the report, including—

(i) the scope and nature of the program;

(ii) the amount expended by the laboratory on each such program for each of the three full fiscal years preceding the date of the report; and

(iii) the number of persons engaged in activities under such program at the laboratory as of the date of the report; and

(B) a discussion of the relevance of the critical technologies identified in the report to the laboratory's strategic mission objectives.

(3) The Secretary shall ensure that core competencies reports submitted pursuant to this section are disseminated broadly to the private sector.

(e) IMPLEMENTATION.—The Secretary shall carry out his responsibilities under this section through the Critical Technologies Planning Council. In carrying out such responsibilities, the Council shall consult with the Critical Technologies Advisory Board and take into consideration the reports prepared pursuant to subsection (d).

(f) FIRST SUBMISSIONS.—(1) The Secretary shall submit the first Department of Energy Critical Technologies Plan to Congress within one year after the date of enactment of this Act. That Plan need not include the matters described in subsection (c)(6).

(2) The first report required by subsection (d) shall be submitted by each Department of Energy laboratory not later than 180 days after the date of the enactment of this Act.

SEC. 104. RELATIONSHIP OF CORE COMPETENCIES TO LABORATORY RESEARCH AND DEVELOPMENT.

(a) ENCOURAGEMENT OF CORE COMPETENCIES.—The Secretary of Energy shall ensure that the laboratory-directed research and development activities of each Department of Energy laboratory include research and development that extends and maintains the vitality of such laboratory's core competencies.

(b) REGULATIONS.—Within 180 days after the date of the enactment of this Act the Secretary shall prescribe regulations to carry out subsection (a). The regulations shall include authority for the director of each Department of Energy laboratory to use funds available for laboratory-directed research and development to support—

(1) research and development in any critical technology within a core competency of such laboratory that is conducted with a view to the commercialization of such technology (regardless of the nature of the commercial application of such technology) under a cooperative research and development agreement entered into in connection with one or more Partnerships established pursuant to title II or as part of any other technology transfer activity permitted under any law applicable to the activities of such laboratory; and

(2) other research or development of a creative or innovative nature which is selected by the director of such laboratory for the purpose of maintaining the vitality of that laboratory in scientific disciplines related to the laboratory's core competencies or to Department of Energy critical technologies.

TITLE II—DEPARTMENT OF ENERGY CRITICAL TECHNOLOGIES PARTNERSHIPS

SEC. 201. DEPARTMENT OF ENERGY CRITICAL TECHNOLOGY PARTNERSHIPS.

(a) ESTABLISHMENT OF PARTNERSHIPS.—Within 18 months after the date of the enactment of this Act, the Secretary of Energy shall establish, in consultation with the Critical Technologies Planning Council and on the basis of proposals solicited during such 18-month period, as many Department of Energy Critical Technology Partnerships as the Secretary determines are necessary to carry out the purpose specified in section 3(3).

(b) PARTNERSHIP PARTICIPANTS.—Each Partnership shall be comprised of one or more Department of Energy laboratories and participants from United States firms and institutions of higher education in the United States, and may include other departments and agencies of the Federal Government, State entities, and any other participants that the Secretary considers appropriate.

(c) LEAD INSTITUTION.—The participants in each Partnership shall designate a lead institution for the Partnership. The lead institution shall direct the activities of the Partnership.

SEC. 202. PARTNERSHIP PROPOSALS.

(a) SUBMISSION OF PARTNERSHIP PROPOSALS.—Each proposal for the establishment of a Partnership by the Secretary shall be submitted to the Secretary by the lead institution acting on behalf of all of the proposed participants in the Partnership.

(b) CONTENT OF PROPOSALS.—Each proposal for the establishment of a Department of Energy Critical Technologies Partnership pursuant to this title shall include the following:

(1) Goals and objectives of the Partnership that are consistent with the purposes of this Act.

(2) A research and development plan to achieve such goals and objectives.

(3) Evidence of expertise of the Partnership participants in developing and utilizing Department of Energy critical technologies.

(4) Provisions for transfer of Department of Energy critical technology through exchange of per-

sonnel among the participants in the Partnership and by other means.

(5) Evidence of the commitment of United States firms to participate in the Partnership, including a description of how personnel, equipment, facilities, and expertise of such firms will be used in the planning, conducting, and monitoring of the technology transfer activities of the Partnership and other Partnership activities.

(6) The demonstration of financial commitment required by subsection (c).

(c) COST SHARING REQUIREMENTS.—Each Partnership proposal shall demonstrate a financial commitment of the non-Federal Government participants to contribute at least 50 percent of the total cost of the Partnership activities. Within the total contribution to be made pursuant to such commitment the non-Federal Government participants may contribute a lesser percentage of the cost incurred during a particular period of Partnership activity or a lesser percentage of the cost of a particular Partnership activity. In the determination of the contribution made by a non-Federal Government participant, there shall be included the fair market value of the participant's contributions of equipment, services, materials, technology transfer activities, and other assets directly related to the costs associated with the goals and objectives of the Partnership, as determined by the Secretary of Energy.

(d) OTHER ASSISTANCE.—The Secretary of Energy shall provide to each Partnership technical assistance and other assistance considered by the Secretary as necessary and appropriate to facilitate the achievement of the goals and objectives of the Partnership.

SEC. 203. SELECTION OF PARTNERSHIPS.

(a) COMPETITIVE SELECTION.—Department of Energy Critical Technologies Partnerships shall be selected through a competitive process prescribed by the Secretary of Energy in consultation with the Critical Technologies Planning Council.

(b) SELECTION CRITERIA.—In establishing a Partnership, the Secretary shall select from among the Partnership proposals that—

(1) demonstrate the most promise of achieving the purpose provided in section 3(3);

(2) propose Partnership activities that have the most significant relevance to Department of Energy missions and to the missions of the other Federal Government participants (if any) in the proposed Partnerships;

(3) demonstrate the strongest level of participation and commitment of United States firms;

(4) offer the greatest potential technical and commercial benefits from the results of research and development in Department of Energy critical technologies; and

(5) establish the most effective programs for the transfer of technology through exchanges of personnel among Partnership participants and through other means.

SEC. 204. PROTECTION OF INFORMATION.

(a) AUTHORITY TO DISCLOSE INFORMATION.—Subject to subsection (b), Department of Energy laboratories and any other departments and agencies of the Federal Government participating in a Partnership may exercise the same authority with respect to research and development under the Partnership as may be exercised by a Federal laboratory pursuant to section 12 of the Stevenson-Wydler Technology Innovation Act of 1980 (15 U.S.C. 3710a) and all other applicable provisions of law.

(b) LIMITATION ON DISCLOSURE.—No officer or employee of the Federal Government may disclose any trade secret or commercial or financial information that is privileged or confidential within the meaning of section 552(b)(4) of title 5, United States Code, and is obtained from a non-Federal Government participant in a Partnership as a result of the conduct of research or other activities of the Partnership. The prohibition in the preceding sentence does not apply to a disclosure made with the consent of such participant.

TITLE III—AUTHORIZATION OF APPROPRIATIONS AND OTHER PROVISIONS

SEC. 301. AUTHORIZATION OF APPROPRIATIONS.

(a) IN GENERAL.—Funds are hereby authorized to be appropriated for the Department of Energy to carry out the responsibilities of the Secretary of Energy under this Act as follows:

(1) For fiscal year 1993, $50,000,000 for atomic energy defense activities, and $50,000,000 for energy research activities.

(2) For each of fiscal years 1994, 1995, 1996, and 1997, $100,000,000 for atomic energy defense activities, and $100,000,000 for energy research activities.

(b) RELATIONSHIP TO OTHER AUTHORIZATIONS AND APPROPRIATIONS.—The funds authorized to be appropriated under subsection (a) are in addition to—

(1) funds authorized to be appropriated for technology transfer in connection with atomic energy defense activities or energy research activities under

any Act enacted before the date of the enactment of this Act; and

(2) funds appropriated for such purposes by any Act enacted before the date of the enactment of this Act.

SEC. 302. AUTHORITY TO WAIVE APPLICABILITY TO CLASSIFIED PROGRAMS.

The Secretary of Energy may waive the applicability of the provisions of this Act to any program or activity of the Department of Energy that is classified in the interest of the national security or foreign policy of the United States.

O

Senator SHELBY. At this time I want to recognize the distinguished Senator from New Mexico, Senator Bingaman.

STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

Senator BINGAMAN. Thank you very much, Mr. Chairman. I will just briefly go through a statement here.

I do think that there is general recognition of the enormous capabilities that the Department of Energy has in technology and particularly those capabilities concentrated in their Federal laboratories. Unfortunately, we do not have a consensus from industry on the value of some of that capability for supporting industry's needs.

The recently issued report from the Council on Competitiveness, which I am sure many of you have read, Gaining New Ground, stated that, "Although the Nation spends approximately $20 billion on the Federal labs, their current culture and direction do not adequately support technology development that strengthens national economic performance." The report goes on to say that much of U.S. industry is convinced from firsthand experience that the labs are not closely integrated with the private sector and, therefore, doubts that sustained investments in them will result in a significant payoff for generic industrial technology.

This legislation, Mr. Chairman, is intended to try to help deal with that problem.

The White House did chair and establish a national critical technology panel and issued a report out of that panel in April. I would point out the Department of Energy was represented on that panel. In fact, one of our witnesses today was on the panel and was very helpful to the panel.

What we are intending to do through this legislation is to ensure that the Department of Energy play a very major role in moving the country ahead in the development and application of these critical technologies that have been identified by the national panel.

I could go into the details of this legislation here. I think that the major thrust of it is very obvious. It calls for industry-driven partnerships. It calls for the Department of Energy to organize itself to pursue in a consistent and long-term fashion development of critical technologies, laying out critical technology plans. I do plan to amend the current version of the bill to establish an office of technology research on the civilian side of the Department of Energy to provide a focus for DOE's support of industry-driven technology partnerships and to bring a balance to the traditional focus on basic research alone. The concept of establishing this Office of Technology Research has been endorsed by House and Senate Appropriations Committees in the appropriations bills that have already been acted upon, at least at the subcommittee level.

So, I do appreciate your holding this hearing, Mr. Chairman, and I look forward to the testimony.

[The prepared statement of Senator Bingaman follows:]

PREPARED STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

BACKGROUND

Mr. Chairman, despite DOE's well respected and well recognized capabilities across a broad spectrum of technologies, industry has strong doubts about the relevancy of the work of the federal laboratories to meet their needs. For example, the recent report from the private sector Council on Competitiveness, Gaining New Ground, stated, "Although the nation spends approximately $20 billion on the federal labs, their current culture and direction do not adequately support technology development that strengthens national economic performance."

Furthermore, the reports goes on to say, "much of U.S. industry is convinced from first-hand experience that the labs are not closely integrated with the private sector and therefore doubts that sustained investments in them will result in a significant payoff for generic industrial technology."

As I initially stated, there is wide recognition that the Department of Energy has unique and extraordinary capabilities in its national laboratories that extend into technologies that are beyond those associated with weapons or energy systems. Despite these capabilities and the associated recognition, the Department of Energy culture tends to less than fully exploit new opportunities (e.g., the high performance computing initiative) as detrimental to their traditional focus on weapons research and on basic energy sciences (such as fusion, particle physics, etc.).

Without a strong connection the commercial sector, which increasingly drives technology, the Department of Energy's national laboratories risk both the ability to carry out their traditional missions and the potential support needed to sustain themselves in the competition for scarce federal R&D resources. Indeed, there is a danger that without these connections to industry the role of the DOE laboratories will be significantly narrowed to their traditional agenda that includes cleanup programs.

OPPORTUNITY

The White House chaired National Critical Technologies Panel, in their report released in April has presented the DOE and its national labs with an opportunity to prioritize their investment in research and development activities on precompetitive development of the critical technologies. The Panel's report identifies 22 technologies which are critical to both national security and economic competitiveness. The national laboratories of the DOE have established capabilities in virtually all of the 22 technologies listed.

Last week I, along with my colleagues Senators Nunn, Hollings and Gore introduced a package of four bills that represent a "Call to Arms" for all of the federal agencies that have an obligation and a stake in responding to the Panel's report. It requires that the federal agencies provide a rational, comprehensive national strategy for promoting U.S. leadership in those core technologies deemed to be critical to future economic prosperity and national security. These bills are based on legislation we have enacted over the last five years to provide for limited and selective government support to complement efforts of the private sector.

The bills recognize that in order for a national technology strategy to be effective it must have industry input and participation along the entire process associated with generic technologies. This process includes the conception, design, and management of any R&D program devoted to these technologies.

The legislation that is the subject of today's hearing, S. 979 is a logical extension of the bills I have introduced last week. It represents an opportunity for the Department of Energy to respond to the "Call to Arms" by implementing the strategy of garnering and integrating the activities of their private sector counterparts with their activities in generic technologies within the framework of cooperative programs.

FEATURES OF S. 979

DOE Critical Technologies Plan

The bill requires the establishment of a Department of Energy Critical Technologies Council to be chaired by the Under Secretary of Energy. The Council, in consultation with members from the Secretary of Energy Advisory Board, is mandated to develop a Department of Energy Critical Technologies Plan. The Plan is to respond to the challenges outlined in the National Critical Technologies Report by building on the core competencies of the individual labs and by working closely with industry.

Industry-Driven Partnerships

Furthermore, the bill fosters the development of strong ties to industry by requiring DOE labs to establish Critical Technology Partnerships comprised of one or more DOE labs and participants from at least two private sector firms. Industry would contribute, over the period of the Partnership, 50% of the required funding. Flexibility is provide to reduce that level at the initial stages of the Partnership when the risks are greatest. The Partnerships would be industry-driven and would be selected on a competitive basis using criteria that include; the level of industry participation, and potential technical and commercial benefits of the technologies.

I plan to amend the current version of the bill to establish an Office of Technology Research in the civilian side of DOE to provide a focus for DOE's support of industry-driven technology Partnerships and a balance to traditional focus on basic research alone. The concept of establishing this Office of Technology Research within DOE has been endorsed by House and Senate Appropriations Committees in the FY 92 Energy and Water Appropriations Bills.

I believe our witnesses for today's hearing represent an appropriate, as well as a distinguished cross-section of all vested interests. I look forward to hearing their testimony.

Senator SHELBY. Thank you, Senator Bingaman.

We first have Ms. Cherri Langenfeld, Department of Energy, Director of the Office of Technology Analysis. Your written statement will be made part of the record and shared with the staff and with every member even if they are not here today. If you would summarize your testimony orally here as quickly as possible.

Ms. LANGENFELD. Thank you. I certainly will.

Senator SHELBY. Thank you.

STATEMENT OF CHERRI J. LANGENFELD, DIRECTOR, OFFICE OF TECHNOLOGY ANALYSIS, DEPARTMENT OF ENERGY

Ms. LANGENFELD. Good afternoon, Mr. Chairman and Senator Bingaman. I am happy to see you here.

I would like to summarize our comments.

We agree generally with the findings set forth in section 2 of S. 979. We also agree with the purpose of the bill, to encourage and enhance the commercialization of the results of DOE research and development. We believe that core competency is a valid approach to addressing strengths in certain DOE laboratories, and we also believe strongly in the partnership concept.

While we support the objectives of S. 979, we have serious concerns about the need for this proposal and whether it is an effective means of accomplishing its objectives. It appears to duplicate, in large part, existing departmental policy and authorizing legislation, including the National Competitiveness Technology Transfer Act of 1989, or the NCTTA. The Secretary of Energy supported the NCTTA which was cosponsored by Senators Bingaman and Domenici. The implementation requirements of S. 979 could dilute rather than enhance the Department's efforts to better utilize the capabilities of our laboratories.

My written statement details our specific concerns with S. 979. In my oral statement, I would like to focus on the Department's enhanced technology transfer program and describe how it accomplishes the objectives of S. 979.

While many of the technology transfer efforts of DOE and its laboratories are not new, the NCTTA provided new impetus to those efforts. It authorized DOE to establish technology transfer as a mission of our government-owned, contractor-operated laboratories (GOCO), including our defense related laboratories. It also extended to the GOCO laboratories the use of cooperative research and development agreements, or CRADA's, which were previously available only to government-owned, government-operated, or GOGO, laboratories. In addition, the NCTTA provided for up to 5 years protection of information and data generated under technology transfer work under CRADA's with industry.

When we looked at the NCTTA back in late 1989, we determined it was time to reexamine the Department's overall approach to technology transfer. To conduct this review, Deputy Secretary Henson Moore authorized the formation of a Department-wide implementation project. All told, nearly 200 people participated in the review and implementation process from nearly every location and office in the DOE network, including the contractor-operated laboratories. In addition, we gathered input from people in industry, State and local government, universities, and other Federal agencies throughout the implementation process.

The project resulted in what we refer to as DOE's enhanced technology transfer program. The basic elements of this program were formally presented to departmental personnel at a technology transfer orientation seminar in January and through a secretarial notice, SEN 30-91, setting the course for technology transfer at the Department of Energy. The philosophy of operations laid out in the SEN starts with a vision, a vision of working in partnership with industry for the purpose of enhancing DOE's mission and U.S. competitiveness. The vision is grounded on a fundamental principle, that the DOE and its laboratories can become more responsive and reliable partners with industry to strengthen our national competitiveness and national security. But to do so, we must continue to improve the speed and certainty with which we conduct joint activities with industry.

The philosophy of operations focuses on three primary goals for accomplishing this enhanced program: increasing the level of U.S. based industry participation in DOE's R&D activities at all stages of program development and execution. The second goal is to increase the level of DOE program, laboratory, and facility activity in transferring technology both to and from the private sector, consistent with our other missions and authorities. And third, to accelerate the process of transferring technology and knowledge to U.S. based private industry and consumers as well as State and local governments.

These goals, in turn, are supported by a series of strategies, and some of these strategies include increasing our use of collaborative cost-shared agreements, providing adequate intellectual property protection, ensuring fairness of opportunity for potential industrial partners, including small businesses, managing conflicts of interests, improving outreach to and feedback from industry, reducing administrative barriers that stand in the way of effective collaboration, working with other agencies, States, and universities to facilitate that process, and creating a robust set of tools or implementing mechanisms by which we accomplish that work.

One of the most important mechanisms has been the technology transfer contract clause which is being incorporated into each of DOE's contracts with our GOCO laboratories, as required by the

NCTTA. These clauses generally spell out a mutually agreed upon set of objectives for technology transfer between DOE and its contractors. Through these clauses, the contractors retain the flexibility to run the technology transfer program at their laboratories, while DOE maintains the appropriate level of management oversight.

We have made significant progress in what we feel is a very short time; 17 of the 21 contract agreements necessary to carry out the NCTTA have been executed, including all of the large multiprogram laboratories. The remaining four agreements are in the final stages of negotiation.

Over 60 CRADA's and joint work statements are being negotiated between DOE's contractor laboratories and industry or have already been executed. These agreements are generally in technology areas that are described in the report of the National Critical Technologies Panel, the Defense Critical Technologies Plan, or the Emerging Technologies Report.

Other indicators of progress, such as royalty income and licensing of intellectual property are also increasing.

Today we are continuing to integrate technology transfer into the Department's existing planning, coordinating, budgeting, and reporting processes, many of which would be duplicated by the requirements of S. 979. To illustrate how we are doing this integration, I would like to describe just a few of the partnerships we have already formed under the enhanced technology transfer program. Even more to the point of today's hearing, I would like to describe these activities in the context of the report of the National Critical Technologies Panel, which addresses 22 technologies in 6 major areas.

The first area is materials. The Department has a large effort in materials research at all its laboratories. For example, the Pittsburgh Energy Technologies Center, or PETC, has a CRADA with the American Society for Testing and Materials to assess measurements of material samples and industry practices. Other laboratories, such as the High Temperature Superconductivity Pilot Centers and the High Temperature Materials Laboratory at Oak Ridge, are continuing to aggressively pursue cooperative research activities for a wide variety of advanced materials and advanced materials processing.

In manufacturing, just this week Martin Marietta Energy Systems signed two CRADA's with the University of Tennessee and the State of Tennessee to facilitate the transfer of advanced manufacturing technologies, especially to small and medium sized firms. These two agreements are part of DOE's advanced manufacturing initiative, AMI, which is funded by the defense programs technology commercialization activity. One of the agreements is also being co-funded by DOE's Office of Environmental Restoration and Waste Management. Last year DOE announced the first agreement under the AMI to form the Specialty Metals Processing Consortium with Sandia National Laboratories and a group of domestic specialty metals firms.

The third area is information and communications. DOE is a major user of the full spectrum of computer systems, software, and communications technologies, and is also a major developer, especially of special purpose hardware and software. Building on our past successes in transferring these technologies through licenses and other cooperative agreements, several laboratories are now seeking CRADA partners in this area. At least one facility is currently in the process of negotiating a CRADA that will involve the testing of new hardware and software for commercial application.

The next area is biotechnology and life sciences. Los Alamos National Laboratory and Life Technologies, Incorporated signed a CRADA in March of this year related to DNA sequencing and human genome research. DOE is also involved in artificial heart pump research through a CRADA between the University of Pittsburgh and PETC involving left ventricular assist devices.

In aeronautics and surface transportation, DOE is heavily involved in energy efficiency research related to transportation and new technologies, such as magnetic levitation. One CRADA between the Midwest Research Institute, the Solar Energy Research Institute, and New Energy Company of Indiana, Limited, seeks to demonstrate an innovative biomass-to-ethanol technology.

Finally, in energy and environment, in addition to our mission of applied energy research, DOE also works on environmental protection and restoration technologies. In one CRADA, PETC and Benmol Corporation are jointly investigating sorbents for SO_2 removal from coal fired flue gases. In another CRADA, Martin Marietta Energy Systems and SPA/AFEAS, a chemical company consortium, are working to assess the impact of alternatives to CFC's on greenhouse gas emissions.

In summary, the Department is committed to improving the transfer of federally funded technology to the private sector. We believe that DOE's programs, laboratories, and facilities are a national resource capable of providing significant scientific, engineering, and technological know-how that can help to achieve the goals of the National Energy Strategy, support national security, and help enhance U.S. industrial competitiveness. Our research and development programs and our technology transfer program are already designed to support a broad spectrum of technologies that are critical to U.S. economic competitiveness and national security, many of which are identified in the reports that are referenced by S. 979.

While DOE could support necessary legislative actions to better tap the resources of DOE's laboratories, we do not believe that S. 979 as drafted will accomplish that goal. We feel that the NCTTA is a more powerful piece of legislation for addressing the Nation's economic and national security goals, and we would like to focus our resources and efforts on making full use of the authorities already provided by the NCTTA through the Department's enhanced technology transfer program. We will, of course, be happy to work with members of the subcommittee to address any remaining needs of DOE's laboratory system and opportunities to further our enhanced technology transfer program.

Mr. Chairman, that concludes my oral statement. I will be happy to respond to any questions.

[The prepared statement of Ms. Langenfeld follows:]

PREPARED STATEMENT OF CHERRI J. LANGENFELD, DIRECTOR, OFFICE OF TECHNOLOGY ANALYSIS, DEPARTMENT OF ENERGY

INTRODUCTION

Good morning, Mr. Chairman, and members of the Subcommittee. I want to thank you for the opportunity to testify on behalf of the Department of Energy (DOE) concerning S. 979, the "Department of Energy Critical Technologies of 1991."

We agree generally with the findings set forth in Section 2 of S. 979 that (1) the United States should maintain a world leadership position in the development and application of technologies critical to national security and economic prosperity, (2) DOE laboratories have wide-ranging and unique capabilities in those technologies, (3) it is in the national interest that these capabilities continue to be fully utilized to enhance U.S. national security interests and economic competitiveness, and (4) increased interaction between DOE and its laboratories and U.S. firms is desirable. We also agree generally with the purpose of S. 979 to encourage and enhance the commercialization of the results of DOE research and development. We believe that core competency is a valid approach to addressing strengths in certain DOE laboratories, as are other terms such as centers of excellence. We also believe strongly in the partnership concept. As this testimony will discuss shortly, DOE is actively pursuing partnership opportunities and entering into cost-shared relationships.

While we support the objectives of S. 979, to better utilize the capabilities of DOE's laboratories to enhance U.S. economic competitiveness and national security, we have serious concerns about the need for this proposal and whether it is an effective means of accomplishing its objectives. It appears to duplicate in large part existing Departmental policy and authorizing legislation, including the National Competitiveness Technology Transfer Act of 1989 (NCTTA). The Secretary of Energy supported the NCTTA, which was co-sponsored by Senators Bingaman and Domenici. In addition, the implementation requirements of S. 979 could dilute, rather than enhance, the Department's efforts to better utilize the capabilities of our laboratories.

Before I describe our specific concerns with S. 979, I would like to provide a context for our comments with an overview of DOE's Enhanced Technology Transfer Program.

DOE'S ENHANCED TECHNOLOGY TRANSFER PROGRAM

While many of the technology transfer efforts of DOE and its laboratories are not new, having been authorized by the Stevenson-Wylder Technology Utilization Act of 1980, the Federal Technology Transfer Act of 1986 and other legislation, the NCTTA provided new impetus to these efforts. It authorized DOE to establish technology transfer as a mission of all DOE Government-owned Contractor-operated (GOCO) laboratories, including our defense-related laboratories. It also extended to the GOCO laboratories the use of CRADAs, which were previously available only to Government-owned Government-operated (GOGO) laboratories, as a major new mechanism for facilitating technology transfer. In addition, the NCTTA provided, for up to five years, protection of information and data generated under technology transfer work under CRADAs with industry.

In evaluating the implications of the NCTTA in late 1989, DOE determined that it was time to re-examine the Department's overall approach to technology transfer. To conduct this review, Deputy Secretary Henson Moore authorized the formation of a Department-wide implementation project. Two groups were formed, one at DOE Headquarters and one for the field. At the headquarter's management level, the Technology Transfer Project Group (TTPG) provided the overall project direction and policy guidance for implementation. To ensure full participation of all laboratories, facilities, and DOE field elements, the Technology Transfer Field Task Force (TTFTF) was formed to provide practical, operations input from the field to the TTPG, and assist in the implementation. All told, nearly 200 people participated in the review and implementation process from nearly every location and office in the DOE network. In addition, the TTPG and TTFTF gathered input from people in industry, State and local government, universities, and other Federal agencies throughout the implementation process.

The work of the TTPG and the TTFTF—conducted over the period January 31, 1990 to January 24, 1991—resulted in what we refer to as DOE's Enhanced Technology Transfer Program. The basic elements of this Program were formally presented to Departmental personnel at DOE's Technology Transfer Orientation Seminar on January 24, 1991, and through a Secretarial Notice, SEN-30-91, "Setting the Course for Technology Transfer at the Department of Energy". A copy of SEN-30-91 is attached as Appendix A.

The Philosophy of Operations laid out in the SEN starts with a vision—a vision of working in partnership with industry for the purpose of enhancing DOE's mission and U.S. competitiveness. The vision is grounded on a fundamental principle—that the DOE and its laboratories and facilities can become more responsive and reliable partners with industry to strengthen our national competitiveness and national security. To do so, we must improve the speed and certainty with which we conduct joint activities with industry.

The Philosophy of Operations focuses on three primary goals for enhancing technology transfer activities at DOE:

(1) Increase the level of U.S.-based industry participation in DOE's R&D activities at all stages of program development and execution;

(2) Increase the level of DOE program, laboratory and facility activity in transferring technology to and from the private sector, consistent with our other missions and authorities; and

(3) Accelerate the process of transferring technology and knowledge to U.S.-based private industry and consumers, as well as State and local governments.

These goals, in turn, are supported by a series of strategies. Some of these strategies include: increasing our use of collaborative, cost-shared agreements with industry; providing adequate intellectual property protection; ensuring fairness of opportunity for potential industrial partners, including small businesses; managing conflict of interest; improving outreach to and feedback from industry; reducing administrative barriers that stand in the way of effective collaboration; working with other agencies, States, and universities to facilitate the technology transfer process; and creating a robust set of "tools" or implementing mechanisms by which to accomplish the work.

One of the most important implementing mechanisms has been the technology transfer contract clause which is being incorporated in each of DOE's contracts with its GOCO laboratories, as required by the NCTTA. These clauses clearly spell out a mutually-agreed upon set of objectives for technology transfer between DOE and its contractors. Through these clauses, the contractors retain the flexibility to run the technology transfer program at their laboratories, while DOE maintains the appropriate level of management oversight. A copy of the model technology transfer contract clause is attached as Appendix B.

Policies and procedures are another important implementing mechanism. The implementation of the laboratory technology transfer programs, through local procedures, is delegated to the contractor organizations by the contract language itself. For DOE organizations, these responsibilities are delegated by Secretarial Notices and DOE Orders.

Wherever possible, we have structured the enhanced technology transfer program to build on existing, effective policies and procedures. However, where existing policies represent barriers to implementing the program, or where supporting policies and procedures are non-existent, DOE will continue to work in partnership with its contractors to produce a comprehensive and coordinated set of DOE guidelines and contractor procedures to fully implement the program.

Finally, in order to sustain the program over the long haul, we are working to establish an improved ongoing education and training program, supported by the necessary tools, to ensure that all DOE and contractor employees are fully prepared to take on the responsibility for technology transfer.

We have made significant progress in a very short time.

- We have established the foundations of an Enhanced Technology Transfer Program for the Department of Energy that builds on the combined experience of DOE's programs, laboratories, and facilities.
- Seventeen of the 21 contract agreements necessary to carry out the NCTTA at DOE's GOCO laboratories have been executed, including all of the large, multi-program laboratories. The remaining four agreements are in the final stages of negotiation.
- Over 60 CRADAs either are being negotiated between DOE's contractor laboratories and industry or already have been executed. As I will describe later, these agreements are generally in technology areas that are described in the Report of the National Critical Technologies Panel, the Defense Critical Technologies Plan, or the Emerging Technologies Report.
- Other indicators of progress such as royalty income and licensing of intellectual property are also increasing.

We have the commitment and focus to continue our progress towards firmly establishing technology transfer as an integral mission of the Department of Energy.

SPECIFIC COMMENTS ON S. 979

Now it is appropriate to address our specific comments on S. 979.

To summarize the provisions of S. 979, the proposed legislation would require DOE to:

- Establish both a Critical Technologies Council and a Critical Technologies Advisory Board.
- Develop a Critical Technologies Plan every two years.
- Promulgate regulations to authorize use of the Laboratory-Directed Research and Development (LDRD) funds for technology transfer and maintaining vitality of core competencies.
- Establish multiple Critical Technology Partnerships.

For these Critical Technology Partnerships, S. 979 also defines the proposal process, requires 50% cost-sharing by non-Federal participants, defines the competitive selection process, and provides for protection of information developed under these partnerships. Finally, S. 979 includes authorization of appropriations for both atomic energy defense activities and energy research activities of the Department of Energy, with a focus on "critical technologies" as defined in the National Critical Technologies Report, the Defense Critical Technologies Report, and the Emerging Technologies Report published by the Department of Commerce.

Each of these provisions will now be addressed in turn.

Comments on Establishing a Critical Technologies Council and a Critical Technologies Advisory Board

The requirement to establish a Critical Technologies Council (Section 101) represents an unnecessary intervention into the Secretary's authority to manage the Department of Energy and its laboratories. The Department already has processes in place to coordinate the activities of the DOE laboratories; to coordinate with other agencies, State entities, U.S. firms, academic groups, and others; to encourage international cooperative scientific and technological activities of these various groups; and to develop an integrated budget request for the Department of Energy, consistent with all of our mission responsibilities. In implementing our enhanced technology transfer program, we are working to integrate technology transfer into all of these processes, such as:

- The Institutional Planning Process for DOE's laboratories;
- DOE's formal, integrated Strategic Planning and Budgeting process for DOE's entire research portfolio;
- Departmental representation on a wide variety of interagency panels and initiatives related to critical technologies, including the National Critical Technologies Panel and preparation of the Defense Critical Technologies Report; and,
- Active participation in other interagency committees, such as the Interagency Committee for Federal Laboratory Technology Transfer, several committees under the Federal Coordinating Council for Science, Engineering, and Technology (FCSSET), and the Working Group on Commercialization of Government Research under the President's Council on Competitiveness.

In addition, the Department is pursuing appropriate collaborations with international participants. These are coordinated with the State Department and other Federal agencies by our Office of International Affairs and Energy Emergencies and the specific program offices.

We are very concerned also about the proposed requirement to include a representative from each DOE laboratory on the DOE Critical Technologies Panel. The tasks defined by S. 979 for this Critical Technologies Panel have a significant policy and management oversight content. Most of DOE's laboratory employees are contractors, not Federal employees. Under the terms of the Federal Advisory Committee Act (P.L. 92-463), the Council would thus have to be formed as an advisory committee because it is not "composed wholly of full-time officers of the Federal government." It is inappropriate for an advisory committee to have such policy and management oversight duties which involve coordinating and planning activities of the Federal government. These functions are inherently governmental in nature and should be performed by Federal officials.

Finally, the proposed Council simply would be unmanageable. DOE is responsible for 9 multi-program laboratories and another 21 single-purpose laboratories. If all laboratories and affected DOE program offices were represented, the Council membership would number nearly 40 people.

We also have concerns about the proposed Critical Technologies Advisory Board (Section 102), which would be formed from the members of the Secretary of Energy Advisory Board (SEAB). SEAB was created to provide the Secretary with long-range advice on DOE missions, activities and operations, and not to provide day-to-day management of particular programs. The sort of short term advice envisioned in Section 102 is at odds with longer range efforts now underway. For example, a SEAB Task Force is already considering the future missions and roles of the DOE national laboratories. Further, the SEAB members represent a very prestigious group of senior management from industry and universities, with full-time commitments outside their part-time participation in SEAB. Section 102 would not only place some of the SEAB members into a short-term oversight role, it would restrict their already-limited availability to advise the Secretary on other important issues affecting the Department.

Comments on Developing a Critical Technologies Plan

The requirement to develop a separate Critical Technologies Plan (S. 103) every two years is duplicative of other ongoing DOE and Administration processes—including the preparation of our annual budget requests. The Department of Energy is responsible for managing multiple missions, including weapons research and production, basic scientific research, applied energy research, and technology transfer. When one compares the Department's current research and development (R&D) portfolio to the three "critical technologies" reports referenced in S. 979, it turns out that DOE already supports research in nearly every critical technology area identified. Coupled with our increased emphasis on an integrated technology transfer program, we believe we have most of the necessary authorities, processes, and incentives in place to continue to improve the contributions our laboratories can make to U.S. competitiveness and national security.

The Department's approach to developing this balanced research portfolio includes developing long term strategic plans and multi-year program plans at the program office level, supported by the Institutional Planning Process at the laboratory level. This Institutional Planning Process serves essentially the same purposes as the proposed DOE Laboratory Core Competencies Reports. At both the DOE level and the laboratory level, we draw on a variety of reports and outside expertise to ensure that we get the maximum amount of leverage from our R&D programs for the benefit of the U.S. taxpayer. The National Energy Strategy, the various "critical technologies" reports, and other analysis, serve as important inputs to developing a comprehensive research portfolio for the Department.

In addition to being duplicative, the proposed DOE Critical Technologies Plan may also be counterproductive to more effective management of the Nation's scientific and technological resources. Other Federal agencies have important, legislated mission responsibilities in certain "critical technologies", such as the Department of Commerce's important role in advanced manufacturing technologies. As I mentioned earlier, the Administration has existing, effective processes for coordinating our research activities on an interagency basis, including the various Federal Coordinating Committee on Science, Engineering and Technology (FCCSET) committees, critical technologies panels, and the President's annual budget process.

Finally, we are concerned about the implementation of this section as it relates to the proposed membership of the Critical Technologies Council. Specifically, we do not believe it is appropriate for the laboratory members of the Council to review and approve on behalf of the Department of Energy the Laboratory Core Competencies Reports prepared by their own laboratories.

Comments on Relationship of Core Competencies to Laboratory-Directed Research and Development

The Department strongly objects to the requirement to prescribe regulations authorizing the director of each Department of Energy (DOE) laboratory to use Laboratory Directed Research and Development (LDRD) funds for (1) technology transfer and (2) maintaining core competencies (Section 104). The Department has recently developed a strengthened LDRD policy and process which allows the directors of multiprogram laboratories flexibility to support creative and innovative research and development activities for the purpose of maintaining the scientific and technical vitality of the laboratory. The requirements of Section 104 regarding maintaining the vitality of core competencies duplicate the Department's existing LDRD policy.

The existing LDRD policy and process is carefully designed to protect against inappropriate use of the funds while allowing flexibility for the laboratory directors to select the projects. Use of the funds for other missions, such as technology transfer, is inappropriate and inconsistent with the fundamental purpose of the LDRD policy. The requirement of Section 104 authorizing use of LDRD funds for technology transfer is in direct violation of the Department's policy. However, the provision of flexibility to the laboratories in technology transfer is properly addressed by DOE's Enhanced Technology Transfer Program described previously. Technology transfer has been explicitly established as a mission of the Department and research and development for the purpose of technology transfer, including under cooperative research and development agreements, will be funded as a direct program activity.

With your permission, a copy of DOE's LDRD policy is attached as Appendix C.

Comments on Establishing Critical Technology Partnerships

In general, the required Critical Technology Partnerships (Section 201) are duplicative of activities being carried out under the authority of the NCTTA and supported by DOE's Enhanced Technology Transfer Program. Other than those programs or activities that are classified in the interest of national security or foreign policy, the technology transfer program at DOE and its laboratories is not restricted in scope. If a laboratory has a technology, facility, or specialized knowledge in an area of interest to industry or other partners, that technology, facility, or knowledge can be accessed through a variety of mechanisms including Cooperative Research and Development Agreements (CRADAs), User Facility Agreements, the Work-for-Others Program, cost-shared contracts, or other forms of cooperative arrangements sponsored by DOE programs. The provisions of S. 979 concerning Partnership participants, Partnership proposals, cost sharing requirements, and selection of Partnerships are also duplicative of DOE's Enhanced Technology Transfer Program.

There are three main areas, however, where S. 979 represents a change from existing policy and authorizations, which do not serve the goals of this legislation.

First, Section 201(c) states that the lead institution for a Partnership would be responsible for directing the activities of the Partnership. Since a Partnership could include State entities, private firms, universities, or other Federal agencies, this could result in one of these non-DOE entities being responsible for directing the activities of one or more DOE laboratories, even when DOE funds are involved. DOE's responsibility for managing its budget and for oversight of the laboratories should not be compromised in this way.

Second, Section 202(c) would establish a 50% cost-sharing requirement across the board. As I mentioned earlier, nearly all of DOE's research activities, regardless of the source of the authorization, are encompassed by one of the "critical technologies" reports. This provision could inadvertently affect DOE's critical research activities that are too long term or high risk to secure a 50% non-Federal cost-share—yet, these activities may be fundamental to one of the "critical technologies" areas referenced by S. 979. Further, this provision could discriminate against small company or university participation in these Partnerships. DOE's Enhanced Technology Transfer Program emphasizes cost-shared, collaborative agreements but allows for flexibility to establish the cost-sharing requirements consistent with the technology and specific projects involved.

Third, it appears that the purpose of Section 204 is to extend the information protection or nondisclosure provisions of section 12 of the Stevenson-Wydler Technology Innovation Act of 1980 (15 U.S.C. 3710a(c)(7) (A) and (B) to include all participating "Federal" laboratories (as defined by section 4 of this Act) and not "laboratories" (as defined by section 12 of this Act) in conducted Partnerships activities. The use of the terms "Federal laboratories," "research and development," and "Partnership," are not defined in the bill and would require further definition to assure the clear meaning of this section with respect to the referenced Act. The present provisions in section 204 represent a fairly significant extension of CRADA material which can be exempted from disclosure under the Freedom of Information Act and would further extend them to provide another exemption to DOE's legislative mandate, such as the Atomic Energy Act, requiring broad dissemination of information. We believe this new exemption requires a careful review to determine its full impact and may require conforming amendments to other legislation.

Finally, to reiterate our concerns about the structure of the proposed Critical Technologies Council, section 203(a) would place the laboratory members of the Council in the position of evaluating Partnership proposals on behalf of the DOE that may have been submitted by their own laboratories.

Comments on Authorization of Appropriations

While we appreciate the desire to give the Department of Energy more money for these activities, the Federal budget situation may defeat your good intentions. That is why we are working to integrate technology transfer into the way the Department and its laboratories conduct our R&D business—not something we do after the research is completed.

To illustrate how well our program is working to fully utilize the laboratory capabilities to enhance U.S. national security interests and economic competitiveness within the Department's existing budget, I'd like to describe just a few of the "partnerships" we have formed under the Department's Enhanced Technology Transfer

Program. Even more to the point of today's hearing, I will describe these activities in the context of the Report of the National Critical Technologies Panel, which addresses 22 technologies in six clusters: materials, manufacturing, information and communications, biotechnology and life sciences, aeronautics and surface transportation, and energy and the environment.

- Materials: The Department has a large effort in materials research at all its laboratories. A very successful collaboration takes place at the scientific facilities, such as the National Synchrotron Light Source at Brookhaven, to characterize materials. There, industry is conducting research at a DOE facility along side DOE researchers and university researchers. The Pittsburgh Energy Technology Center (PETC) has a CRADA with the American Society for Testing and Materials to assess measurements of samples and industry practices. Other laboratories, such as the three High Temperature Superconductivity Pilot Centers and the High Temperature Materials Laboratory at Oak Ridge, are continuing to aggressively pursue cooperative research activities for a wide variety of advanced materials.
- Manufacturing: Just this week, Martin Marietta Energy Systems signed two CRADAs with the University of Tennessee and the State of Tennessee to facilitate the transfer of advanced manufacturing technologies, especially to small and medium sized firms. These two agreements are part of DOE's Advanced Manufacturing Initiative (AMI), which is funded by the Defense Programs Technology Commercialization activity. One of the agreements is being co-funded by DOE's Office of Environmental Restoration and Waste Management. Last year, DOE announced the first agreement under the AMI, to form the Specialty Metals Processing Consortium with Sandia and domestic specialty metals firms.
- Information and communications: DOE is a major user of the full spectrum of computer systems, software, and communications technologies and is also a major developer, especially of special purpose hardware and software. Building on our past successes in transferring these technologies through licenses and cooperative research efforts, several laboratories are seeking CRADA partners in this area. At least one facility is in the process of negotiating a CRADA that will involve the testing of new hardware and software for commercial application.
- Biotechnology and life sciences: Los Alamos National Laboratory and Life Technologies, Inc. signed a CRADA in March of this year related to DNA sequencing and human genome research. DOE is also involved in artificial heart pump research through a CRADA between the University of Pittsburgh and PETC involving Left Ventricular Assist Devices.
- Aeronautics and surface transportation: DOE is heavily involved in energy efficiency research related to transportation and new technologies such as magnetic levitation. One CRADA between the Midwest Research Institute, the Solar Energy Research Institute and New Energy Company of Indiana, Ltd. seeks to demonstrate an innovative Biomass-to-Ethanol Technology.
- Energy and environment: In addition to our mission of applied energy research, DOE also works on environmental protection and restoration technologies. In one CRADA, PETC and Benmol Corporation are jointly investigating sorbents for SO_2 removal from coal fired flue gases. In another CRADA, PETC and Consolidation Coal are evaluating reconstituted coal fuels. In addition, Martin Marietta Energy Systems and SPA/AFEAS are working under a CRADA to assess the impact of alternatives to CFC's on greenhouse gas emissions.

CONCLUSION

The Department of Energy is committed to improving the transfer of Federally-funded technology to the private sector. We believe that the DOE's programs, laboratories and facilities are a national resource, capable of providing significant scientific, engineering, and technological know-how that can help to achieve the goals of the National Energy Strategy (NES), support national security, and help enhance U.S. industrial competitiveness. Our research and development programs, and our technology transfer program, are already designed to support a broad spectrum of technologies that are critical to U.S. economic competitiveness and national security, many of which are identified in the reports that are referenced by S. 979.

While DOE could support necessary legislative actions to better "tap" the resources of DOE's laboratories, we do not believe that S. 979 as drafted will accomplish that goal. We feel that the NCTTA is a more powerful piece of legislation for addressing the nation's economic and national security goals and we would like to focus our resources and efforts on making full use of the authorities already provided by the NCTTA through the Department's Enhanced Technology Transfer Program. We will, of course, be happy to work with members of the Committee to address any remaining needs of DOE's laboratory system and opportunities to further our Enhanced Technology Transfer Program.

(Appendix A)

SECRETARY OF ENERGY NOTICE 30-91

Date: January 23, 1991
Subject: Setting the Course for Technology Transfer at the Department of Energy

In my notice of September 5, 1989, I outlined the management objectives I felt were necessary to set a "new course" for the Department of Energy (DOE) in executing its mission responsibilities. This notice sets the course for one of those initiatives most important to achieving the Nation's energy, environmental, economic, and national security goals: technology transfer.

Because U.S. competitiveness in international markets is seriously challenged, I feel that it is important to move as quickly as possible to expand and enhance DOE's cooperative work with industry. Shorter product cycles demand faster translation of research and development (R&D) into marketable products and services, and existing transfer processes are often too slow to meet these requirements. Efforts to utilize the technologies and capabilities residing in DOE facilities to provide assistance to the private sector in improving our industrial competitiveness must be made more efficient and effective than in the past. The following "Philosophy of Operations", sets the vision and policy framework for immediately establishing an enhanced technology transfer program at the Department of Energy.

PHILOSOPHY OF OPERATIONS: TECHNOLOGY TRANSFER

STATEMENT OF PURPOSE

Preamble

Through the National Energy Strategy (NES) process, it has become clear that basic scientific research and the development of advanced energy technologies is fundamental to the success of any national energy strategy. Further, the success of every technology-related strategy proposed in the NES depends on rapidly transferring the results of research and development activities into use. In fact, these fundamental principles apply across a broad range of national strategies, from agriculture, to space, to national defense.

At the Department of Energy, our challenge is to support the search for fundamental knowledge, and then to help translate that knowledge into practical applications for the U.S. economy and U.S. defense. The DOE's programs, laboratories and facilities are a national resource, capable of providing significant scientific, engineering, and technological know-how that can help achieve the goals of the NES, support national security, and help enhance U.S. industrial competitiveness.

We have long been successful at sharing the results of our basic research programs (knowledge transfer)—both to and from the international scientific community. We have also proven our ability to support the transfer of applied research activities (direct transfer)—both to and from industry, universities, and State and local governments. Finally, our engineers and scientists have worked successfully with industry to find commercial applications for the results of many basic science and defense weapons research programs (spin-off and dual use transfer).

However, there is more that we can do. By building even closer partnerships with industry, other agencies, Congress, State and local governments, trade associations, universities, and other organizations, we can help "bridge the gap" between the point where Federal R&D has historically stopped and the point where industry commitment to commercialization can be made. With the leadership and support of DOE and contractor management, the Department's programs, field offices, laboratories and other facilities can be more responsive to the needs of U.S. industry. In this way, we can help U.S. industry develop economically and environmentally superior products and processes, create new jobs, enhance the skill level of the U.S. labor force, and increase the tax base, all of which contribute to U.S. economic strength and national security.

Mission

The DOE technology transfer mission is to help enhance U.S. competitiveness and national security, by expanding and accelerating the transfer of Federally-funded technologies and knowledge into commercial applications by U.S.-based industry.

Goals

In support of this mission, DOE will:

1. Increase the level of U.S.-based industry participation in DOE's research and development at all stages of program development and execution.
2. Increase the level of DOE program and laboratory activity in transferring technology, consistent with other program missions and authorities.
3. Accelerate the process of transferring technology and knowledge to U.S.-based private industry and consumers and State and local governments.

MANAGEMENT PHILOSOPHY

Based on the analysis of the public input for the National Energy Strategy, as well as the inputs made by an intra-Departmental working group, DOE has developed a comprehensive, integrated technology transfer strategy. Our approach centers on a philosophy of fostering strengthened collaborative relationships between Federally-supported programs and U.S. private industry throughout all phases of the programs. One of the overriding principles of our approach is that technology transfer can be improved by introducing more "market pull," where technology development efforts are more focused on meeting an identified need. To encourage increased collaboration, we need to:

- Improve the speed of the technology transfer process; and
- Improve the predictability of that process.

Improving the speed of the process is supported by the principles of localized decision-making, flexibility to meet the varying needs of outside partners, and simplified procedures. Improving the predictability of the process is supported by the principles of management oversight, consistency and accountability across operations, and clearly articulated policies and guidelines. Achieving the appropriate balance requires a close partnership between DOE, its contractors, industry, and other participants in the technology transfer process.

STRATEGIES

DOE will build on existing, successful technology transfer models to pursue the following strategies in accomplishing our goals:

Goal 1: Increase industry participation

- Increase the use of cost-shared, collaborative agreements to better leverage public and private funds and to further encourage "market pull" of new technologies into and out of DOE programs and facilities.
- Protect technologies and information that can be used to enhance U.S. competitiveness or national security, to the extent permitted by U.S. law, international treaties and agreements, and consistent with other DOE missions.
- Establish clear policies on participation in collaborative programs and licensing agreements to ensure that the economic and technological benefits accrue to the U.S. economy.
- Encourage all Departmental elements and other facilities to ensure fairness of opportunity for potential participants, recognizing the special needs of small businesses and non-profit organizations.

Goal 2: Increase DOE participation

- Establish technology transfer as a fully-integrated mission of all Departmental elements, laboratories, and other appropriate facilities and evaluate the performance of each organization relative to fulfilling this mission.
- Provide the sustained funding and resources necessary to implement the technology transfer mission, including support for cost-shared programs to develop "spinoff" applications and the development of generic, pre-competitive technologies.
- Expand the use of incentives and recognition programs that encourage participation of Federal and contractor employees in the technology transfer program, including recognition for accelerating the conversion of DOE technology and know how into a form that can be protected, such as patents, copyrights, data, engineering drawings, etc.
- Maintain support for basic scientific and technological research programs that are important to the Nation's long term energy, economic, environmental, and national security goals, in order to retain a national pool of scientific and engineering expertise.

Goal 3: Accelerate the process

- Develop more effective technology transfer partnerships between the DOE, its laboratories and other facilities, other Federal agencies, State and local governments, universities, industry, and various professional and industry associations.
- Extend the use of end-user and technical advisory groups, industry consortia, joint ventures, and other interactive mechanisms to ensure industry input in all phases of research and development.
- Improve "outreach" to industry, provide greater access to facilities that promote technology deployment, and increase the exchange of personnel and information between the laboratories, production plants and other facilities, and universities and industry.
- Eliminate administrative barriers to collaboration between industry and DOE or its agents, by simplifying procedures and promoting greater consistency across operations.

ROLES AND RESPONSIBILITIES

There are four general levels of management at the DOE that must be considered in identifying roles and responsibilities for managing technology transfer:

- The Secretary of Energy. As the senior Departmental official, the Secretary of Energy provides the broad policy direction for the Department and implements technology transfer programs and policies through the Program Secretarial Officers. The Secretary relies on a variety of Senior Staff Officers to advise him and help implement his policy directions. These include the Deputy Secretary, Under Secretary, Deputy Under Secretary for Policy, Planning and Analysis, General Counsel, Assistant Secretary of Congressional Affairs, and the Directors of various staff support offices.
- Program Secretarial Officers. This category includes Assistant Secretaries and Directors who have line management responsibilities for DOE's R&D and technology transfer programs (e.g., Energy Research, Fossil Energy, Defense Programs, Conservation and Renewable Energy, etc.) Some of these officers also have management oversight responsibility for DOE's field offices, laboratories and facilities.
- Field Office Managers. These offices include the eight operations offices and their affiliated area and regional support offices. In the case of Fossil Energy, this category may also encompass the Energy Technology Centers at Morgantown, WV, and Pittsburgh, PA, for certain activities.
- Laboratory Director or Equivalent. Most of DOE's laboratories and facilities are run by Management and Operating (M&O) contractors. While the titles may vary, each laboratory and facility has a lead manager, employed by the contractor, who acts as an agent of the contractor in conducting technology transfer activities.

The broad roles and responsibilities of each of these management levels are as follows:

DOE Secretary

- Establish the broad policies and guidelines that serve as the consistent framework within which the Department's technology transfer activities are conducted.
- Coordinate with other agencies, Congress, and other national and international organizations in establishing policies and programs that facilitate private sector access to the scientific and technological capability of DOE and its laboratories and facilities.
- Provide the required financial and human resources, including the necessary training and education, to support the technology transfer missions of DOE and its laboratories and other facilities.
- Delegate, to the extent feasible, decision-making for the technology transfer program to the appropriate organizational level for effective implementation of the program, and provide adequate flexibility for these organizations to be responsive to the needs of the marketplace.
- Establish and communicate the standards of performance and success by which these organizations will be measured, and review that progress.

Program Secretarial Officers

- Determine each program's technology transfer role, within the broad policy framework of the Department and consistent with other programmatic missions and statutory authorities.

- Provide input to the development of cross-cutting Departmental policies and procedures, assure coordination of activities that have multi-program implications, and promote the sharing of information on activities and "lessons learned" in technology transfer both inside and outside DOE.
- Develop the supporting policies, strategies and plans to implement each program's technology transfer mission, consistent with other program missions, and to further delegate decision-making responsibility, as appropriate, to the field offices and facility directors.
- Seek the necessary resources to implement these plans, and maintain oversight of those resources to assure appropriate uses.
- Evaluate the progress and effectiveness of these technology transfer programs, whether they are managed directly by the program office or whether they have been delegated to a field office manager or facility director.
- Conduct outreach initiatives that focus on program-specific third-party participants, such as industry consortia, State and local governments, universities, trade associations, etc.

Field Office Managers

- Support and implement the directions and policies of the Secretary and Program Secretarial Officers.
- Assist in formulating and refining Departmental and programmatic policies and procedures.
- Negotiate appropriate technology transfer contract provisions with the M&O contractors on behalf of DOE.
- Review and approve collaborative agreements in consultation with the Program Secretarial Officers.
- Develop and improve local procedures for processing these agreements in a timely manner consistent with the guidance of DOE management.
- Appraise and report on the technology transfer program of each DOE laboratory and facility.
- Assure protection of intellectual property and commercially valuable information for the technology transfer mission.

Laboratory Director or Equivalent

- Plan and conduct the laboratory or facility technology transfer program.
- Provide input on policies and procedures.
- Comply with contract provisions and any other agreed-upon policies, and define supporting lab facility procedures where required.
- Plan, monitor, and evaluate the laboratory's or facility's technology transfer program, consistent with Departmental and programmatic guidance.
- Demonstrate fiscal and mission responsibility to all missions while conducting the technology transfer mission.

AUTHORIZATIONS

As part of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), Congress enacted the National Competitiveness Technology Transfer Act (NCTTA) of 1989. The law further amends the Stevenson-Wydler Technology Innovation Act of 1980, which was previously amended by the Technology Transfer Act of 1986. The NCTTA directed DOE to offer contract provisions to establish technology transfer as a mission of DOE Government-Owned, Contractor-Operated (GOCO) research and development laboratories, setting forth new contract provisions and operating requirements for government agencies and their GOCOs. In addition, the law provides GOCO R&D laboratory directors with the authority to negotiate and enter into Cooperative Research and Development Agreements (CRADAs) subject to approved joint work statements, similar to authority previously granted to the directors of Government-Owned, Government-Operated R&D laboratories.

The technology transfer mission of the R&D laboratories and facilities, including CRADAs, will be conducted in a manner that is consistent with the policy, principles, and purposes of the Stevenson-Wydler Technology Innovation Act of 1980 (as amended) (15 U.S.C. 3710(a)); Section 3132(b) of Public Law 101-189; chapter 18 of title 35, U.S. Code, commonly referred to as Bayh-Dole (35 U.S.C. 200 et seq); Section 152 of the Atomic Energy Act of 1954 (as amended) (42 U.S.C. 2182); Section 9 of the Federal Nonnuclear Energy Research and Development Act of 1974 (42 U.S.C. 5908); and Executive Order 12591 of April 10, 1987, and consistent with the overall technology transfer mission of the Department. The Office of Naval Nuclear Reactors will continue to perform technology transfer in accordance with applicable law and existing program policies.

The Deputy Secretary will continue to coordinate Departmental efforts to implement this enhanced technology transfer strategy.

(Appendix B)

TECHNOLOGY TRANSFER CONTRACT CLAUSE

I. TECHNOLOGY TRANSFER

This clause has as its purpose, implementation of the National Competitiveness Technology Transfer Act of 1989 (Sections 3131, 3132, 3133, and 3159 of P.L. 101-189) and takes precedence over any other provisions of this Contract to the contrary.

A. Definitions

1. Contractor's Laboratory Director means the individual who has supervision over all or substantially all of the Contractor's operations at the Laboratory.

2. Intellectual Property means trademarks protected by state law and patents, trademarks, copyrights, mask works, and other forms of comparable property rights protected by Federal Law and their foreign counterparts.

3. Cooperative Research and Development Agreement (CRADA) means any agreement entered into between the contractor as operator of the Laboratory and one or more parties including at least one non-Federal party under which the Government, through its laboratory, provides personnel, services, facilities, equipment, and other resources with or without reimbursement (but not funds to non-Federal parties) and the non-Federal parties provide funds, personnel, services, facilities equipment, or other resources toward the conduct of specified research or development efforts which are consistent with the missions of the Laboratory; except that such term does not include a procurement contract grant, or cooperative agreement as those terms are used in sections 6303, 6304, and 6305 of Title 31 of the United States Code.

4. Joint Work Statement (JWS) means a proposal for a CRADA prepared by the Contractor, signed by the Contractor's Laboratory Director or designee which describes the following:

   a. Purpose;

   b. Scope of Work which delineates the rights and responsibilities of the Government, the Contractor and Third Parties, one of which must be a non-Federal party;

   c. Schedule for the work; and

   d. Cost and resource contributions of the parties associated with the work and the schedule.

B. Authority

1. In order to ensure the full use of the results of research and development efforts of, and the capabilities of, the Laboratory, technology transfer, including Cooperative Research and Development Agreements (CRADAs), is established as a mission of the Laboratory consistent with the policy, principles and purposes of Sections 11(a)(1) and 12(g) of the Stevenson-Wydler Technology Innovation Act of 1980 as amended (15 U.S.C. 3710a); Section 3132(b) of P.L. 101-189 and of Chapter 38 of the Patent Laws (35 U.S.C. 200 et seq.); Section 152 of the Atomic Energy Act of 1954 as amended (42 U.S.C. 2182); Section 9 of the Federal Non-Nuclear Act of 1974 (42 U.S.C. 5908); and Executive Order 12591 of April 10, 1987.

2. The Contractor shall conduct technology transfer activities with a purpose of providing benefit from Federal research to U.S. industrial competitiveness.

3. In pursuing the technology transfer mission, the Contractor is empowered to conduct activities including but not limited to: identification of and protection of Intellectual Property, negotiation of licensing agreements and assignments for Intellectual Property that the Contractor controls or owns, entering into CRADAs, providing technical consulting and personnel exchanges, conducting science education activities and reimbursable Work for Others (WFO), provide information exchanges and make available Laboratory user facilities. It is fully expected that the Contractor shall use all of the mechanisms available to it to accomplish this technology transfer mission, including, but not limited to, user facilities, WFO, science education activities, consulting, personnel exchanges, and licensing in accordance with this clause.

C. Allowable Costs

(Applies to Contractors performing technology transfer activities under this clause and from which all income is returned to the Laboratory for use under the Contract.)

1. The Contractor shall establish and carry out its technology transfer efforts through appropriate organizational elements consistent with the requirements for an Office of Research and Technology Applications (ORTA) pursuant to Paragraphs (b) and (c) of Section 11 of the Stevenson-Wydler Technology Innovation Act of 1980 as amended (15 U.S.C. 3710). The costs associated with the conduct of technology transfer through the ORTA and activities associated with obtaining, maintaining, licensing, and assigning Intellectual Property rights, increasing the potential for the transfer of technology, and the widespread notice of technology transfer opportunities, shall be deemed allowable provided that such costs meet the other requirements of the allowable costs provisions of this Contract. These costs in any fiscal year shall not exceed an amount equal to 0.5 percent of the Federal research and development budget (operating including Work For Others) of the Laboratory for that fiscal year, without written approval of the Contracting Officer, in addition to any separately designated funds.

2. The Contractor's participation in litigation to enforce or defend Intellectual Property claims associated with its technology transfer efforts shall be as provided in the clause entitled "Litigation and Claims" of this Contract.

D. Conflicts of Interest—Technology Transfer

The Contractor shall develop implementing procedures that seek to avoid employee and organizational conflicts of interest, or the appearance of conflicts of interest, in the conduct of its technology transfer activities. Such implementing procedures shall be provided to the Contracting Officer for review and approval within sixty (60) days after execution of this clause. The Contracting Officer shall have thirty (30) days thereafter to approve or require specific changes to such procedures. Such implementing procedures shall include procedures to:

1. Inform employees of and require conformance with standards of conduct and integrity, in connection with the CRADA activity in accordance with the provisions of Paragraph II.E. of this clause.
2. Review and approve employee activities so as to avoid conflicts of interest arising from commercial utilization activities relating to Contractor-developed Intellectual Property;
3. Conduct work performed using royalties so as to avoid interference with or adverse effects on ongoing DOE projects and programs;
4. Conduct activities relating to commercial utilization of Contractor-developed Intellectual Property so as to avoid interference with or adverse effects on user facility or WFO activities of the Contractor;
5. Conduct DOE funded projects and programs so as to avoid the appearance of conflicts of interest or actual conflicts of interest with non-Government funded work;
6. Notify the Contracting Officer with respect to any new work to be performed or proposed to be performed under the Contract for the Department or other Federal agencies where the new work or proposal involves Intellectual Property in which the Contractor has obtained or intends to request or elect title;
7. Except as provided elsewhere in this Contract, obtain the approval of the Contracting Officer for any licensing of or assignment of title to Intellectual Property rights by the Contractor to any business or corporate affiliate of the Contractor;
8. Obtain the approval of the Contracting Officer prior to any assignment, exclusive licensing, or option for exclusive licensing, of Intellectual Property to any current Laboratory employee or consultant or to any person who has been a Laboratory employee or consultant within the previous two years or to a company in which he or she is a principal;
9. Notify non-Federal sponsors of WFO activities, or non-Federal users of user facilities, of any relevant Intellectual Property Interest of the Contractor prior to execution of WFOs or user agreements.

E. Fairness of Opportunity

In conducting its technology transfer activities, the Contractor shall prepare procedures and take all reasonable measures to ensure widespread notice of availability of technologies suited for transfer and opportunities for exclusive licensing and joint research arrangements. The requirement to widely disseminate the availability of technology transfer opportunities does not apply to a specific application originated outside of the Laboratory.

F. U.S. Industrial Competitiveness

1. In the interest of enhancing U.S. Industrial Competitiveness, the Contractor shall, in its licensing and assignments of Intellectual Property, give preference in such a manner as to enhance the accrual of economic and technological benefits to the U.S. domestic economy. The Contractor shall consider the following factors in all of its licensing and assignment decisions:

(a) whether any resulting design and development will be performed in the United States and whether resulting products, embodying parts, including components thereof, will be substantially manufactured in the United States; or

(b)(i) whether the proposed licensee or assignee has a business unit located in the United States and whether significant economic and technical benefits will flow to the United States as a result of the license or assignment agreement; and further,

(ii) whether in licensing any entity subject to the control of a foreign company or government, such foreign government permits United States agencies, organizations or other persons to enter into cooperative research and development agreements and licensing agreements, and have policies to protect United States intellectual property rights.

If the Contractor determines that neither of the above two sets of conditions is likely to be fulfilled, the Contractor, prior to entering into such an agreement, must obtain the approval of the Contracting Officer. The Contracting Officer shall act on any such requests for approval within thirty (30) days.

2. The Contractor agrees to be bound by the provisions of 35 U.S.C. 204.

G. Indemnity—Product Liability

In entering into written technology transfer agreements, including but not limited to, research and development agreements, licenses, assignments and CRADAs, the Contractor agrees to include in such agreements a requirement that the Contractor and the U.S. Government be indemnified for all damages, costs, and expenses, including attorneys' fees, arising from the commercialization and utilization of such technologies, including, but not limited to, the making, using, selling or exporting of products, processes, or services derived from the transferred technology.

H. Disposition of Income

(Applies to Contractors conducting technology transfer activities under this clause and from which all income is returned to the Laboratory for use under the Contract.)

1. Royalties or other income earned or retained by the Contractor as a result of performance of authorized technology transfer activities herein shall be used by the Contractor for scientific research, development, technology transfer, and education at the Laboratory, consistent with the research and development mission and objectives of the Laboratory and subject to Section 12(b)(5) of The Stevenson-Wydler Technology Innovation Act of 1980, as amended (15 U.S.C. 3710a(b)(5)) and Chapter 38 of the Patent Laws (35 U.S.C. 200 et seq.) as amended through [insert the date of this modification]. If the amounts of such royalties and income received during any fiscal year exceed 5 percent of the Laboratory's budget for that fiscal year, 75 percent of such excess amounts shall be paid to the Treasury of the United States, and the remaining amount of such excess shall be used by the Contractor for the purposes as described above in this paragraph. Any inventions arising out of such scientific research and development activities shall be deemed to be "Subject Inventions" under the Contract.

2. The Contractor shall include as a part of its annual Laboratory Institutional Plan or other such annual document a plan setting out those uses to which royalties and other income received as a result of performance of authorized technology transfer activities herein, will be applied at the Laboratory, and at the end of the year, provide a separate accounting for how the funds were actually used. Under no circumstances shall these royalties and income be used for an illegal augmentation of funds furnished by the U.S. Government.

3. The Contractor shall establish a policy for making awards or sharing of royalties with Contractor employees, other coinventors and coauthors, including, Federal employee coinventors when deemed appropriate by the Contracting Officer.

I. Transfer to Successor Contractor

In the event of termination or expiration of this Contract, any unexpended balance of income received for use at the Laboratory shall be transferred, at the Contracting Officer's request, to a successor contractor, or in the absence of a successor contractor, to such other entity as designated by the Contracting Officer. The Contractor shall transfer title, as one package, to the extent the Contractor retains title, in all patents and patent applications, licenses, accounts containing royalty revenues from such license agreements, including equity positions in third party entities, and other Intellectual Property rights which arose at the Laboratory, to the successor contractor or to the Government as directed by the Contracting Officer.

J. Technology Transfer Affecting the National Security

1. The Contractor shall notify and obtain the approval of the Contracting Officer, prior to entering into any technology transfer arrangement, when such technology or any part of such technology is classified or sensitive under Section 148 of the Atomic Energy Act (42 U.S.C. 2168). Such notification shall include sufficient information to enable DOE to determine the extent that commercialization of such technology would enhance or diminish security interests of the United States, or diminish communications within DOE's nuclear weapons production complex. DOE shall use its best efforts to complete its determination within sixty (60) days of the Contractor's notification, and provision of any supporting information, and DOE shall promptly notify the Contractor as to whether the technology is transferable.

2. The Contractor shall include in all of its technology transfer agreements with third parties, including, but not limited to, CRADAs, licensing agreements and assignments, notice to such third parties that the export of goods and/or Technical Data from the United States may require some form of export control license or other authority from the U.S. Government and that, failure to obtain such export control license, may result in criminal liability under U.S. laws.

3. For other than fundamental research as defined in National Security Decision Directive 189, the Contractor is responsible to conduct internal export control reviews and assure that technology is transferred, in accordance with applicable law.

K. Records

The Contractor shall maintain records of its technology transfer activities, in a manner and to the extent satisfactory to the DOE, and specifically including, but not limited to, the licensing agreements, assignments and the records required to implement the requirements of paragraphs E., F., and H., herein and shall provide reports to the Contracting Officer to enable DOE to maintain the recording requirements of Section 12(c)(6) of the Stevenson-Wydler Technology Innovation Act of 1980 as amended (15 U.S.C. 371Oa(c)(6)). Such reports shall be made annually in a format to be agreed upon between the Contractor and the DOE and in such a format which will serve to adequately inform DOE of the Contractor's technology transfer activities while protecting any data not subject to disclosure under the Rights in Technical Data clause and Section II. herein. Such records shall be made available in accordance with the clauses of this Contract pertaining to inspection, audit and examination of records.

L. Reports to Congress

To facilitate DOE's reporting to Congress, the Contractor is required to annually submit to DOE a technology transfer plan for conducting its technology transfer function for the upcoming year, including plans for securing Intellectual Property rights in Laboratory innovations with commercial promise and plans for managing such innovations so as to benefit the competitiveness of United States industry. This plan shall be provided to the Contracting Officer on or before October 1st of each year.

M. Oversight and Appraisal

The Contractor is responsible for developing and implementing effective internal controls for all technology transfer activities consistent with the audit and record requirements of this Contract. Laboratory Contractor performance in implementing the technology transfer mission and the effectiveness of the Contractor's procedures will be evaluated by the Contracting Officer as part of the annual appraisal process, with input from the cognizant Secretarial Officer or program office.

II. TECHNOLOGY TRANSFER THROUGH COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

Upon approval of the Contracting Officer and as provided in a DOE approved Joint Work Statement (JWS), the Laboratory Director or his designee may enter into CRADAs on behalf of the DOE subject to the requirements set forth herein.

A. Review and Approval of CRADAs

1. Each JWS shall be submitted to the Contracting Officer for approval. The Contractor's Laboratory Director or designee shall provide a program mission impact statement and shall include an impact statement regarding related Intellectual Property rights known by the contractor to be owned by the Government to assist the Contracting Officer in his approval determination.

2. The Contractor shall also include (specific to the proposed CRADA), a statement of compliance with the Fairness of Opportunity requirements of paragraph I.E. above.

3. Within ninety (90) days after submission of a JWS, the Contracting Officer shall approve, disapprove or request modification to the JWS. If a modification is required, the Contracting Officer shall approve or disapprove any resubmission of the JWS within thirty (30) days of its resubmission, or ninety (90) days from the date of the original submission, whichever is later. The Contracting Officer shall provide an explanation to the Contractor's Laboratory Director or designee of any disapproval or requirement for modification of a JWS.

4. Upon approval of a JWS, the Contractor's Laboratory Director or designee may submit a CRADA, based upon the approved JWS, to the Contracting Officer. The Contracting Officer, within thirty (30) days of receipt of the CRADA, shall approve or request modification of the CRADA. If the Contracting Officer requests a modification of the CRADA, an explanation of such request shall be provided to the Laboratory Director.

5. The Contractor shall not enter into, or begin work under, a CRADA until approval of the CRADA has been granted by the Contracting Officer. The Contractor may submit its proposed CRADA to the Contracting Officer at the time of submitting its proposed JWS or any time thereafter. However, the Contracting Officer is not obligated to respond under subparagraph 4. above until within thirty (30) days after approval of the JWS or thirty (30) days after submittal of the CRADA, whichever is later.

B. Selection of Participants

The Contractor's Laboratory Director or designee in deciding what CRADA to enter into shall:

1. Give special consideration to small business firms, and consortia involving small business firms;
2. Grant U.S. preference in accordance with the licensing and assignment requirements of paragraph I.F. above;
3. Provide Fairness of Opportunity in accordance with the requirements of paragraph I.E. above; and
4. Give consideration to the Conflicts of Interest requirements of paragraph I.D. above.

C. Withholding of Data

1. The Contractor may provide for appropriate protection against dissemination of data produced as a result of research and development activities conducted under a CRADA, for a period of up to five (5) years from the time the data is first produced. Such data must be data that would be a trade secret or commercial or financial data that would be privileged or confidential, if such data had been obtained from a non-Federal Third Party. Since such data is exempt from disclosure under the Freedom of Information Act, the DOE shall cooperate with the Contractor in withholding such data.

2. Unless otherwise expressly approved by the Contracting Officer in advance for a specific CRADA, the Contractor agrees, at the request of the Contracting Officer, to transmit such data to other DOE facilities for use by DOE or its Contractors by or on behalf of the Government. When data protected pursuant to paragraph C.1. above is so transferred, the Contractor shall clearly mark the data with a legend setting out the restrictions against private use and further dissemination, along with the expiration date of such restrictions.

3. In addition to its authority to license Intellectual Property, the Contractor may enter into licensing agreements with third parties for data developed by the Contractor under a CRADA subject to other provisions of this Contract. However, the Contractor shall neither use the protection against dissemination nor the licensing of data as an alternative to the submittal of invention disclosures which include data protected pursuant to paragraph C.1. above.

D. Work For Others and User Facility Programs

1. WFO and User Facility Agreements (UFAs) are not CRADAs and will be available for use by the Contractor in addition to CRADAs for achieving utilization of

employee expertise and unique facilities for maximizing technology transfer. The Contractor agrees to inform prospective CRADA participants, which are intending to substantially pay full cost recovery for the effort under a proposed CRADA, of WF0 and UFA opportunities, including Class Waiver provisions associated therewith.

2. Where the Contractor believes that the transfer of technology to the U.S. domestic economy will benefit from, or other equity considerations dictate, an arrangement other than the Class Waiver of patent rights to the sponsor in WF0 and UFAs, a request may be made to the Contracting Officer for an exception to the Class Waivers.

E. Conflicts of Interest

1. Except as provided in paragraph 3. below, the Contractor shall assure that no employee of the Contractor shall have a substantial role (including an advisory role) in the preparation, negotiation, or approval of a CRADA, if, to such employee's knowledge:

a. Such employee, or the spouse, child, parent, sibling, or partner of such employee, or an organization (other than the Contractor) in which such employee serves as an officer, director, trustee, partner, or employee—

(1) holds financial interest in any entity, other than the Contractor, that has a substantial interest in the preparation, negotiation, or approval of the CRADA;

(2) receives a gift or gratuity from any entity, other than the Contractor, that has a substantial interest in the preparation, negotiation, or approval of the CA; or

b. A financial interest in any entity, other than the Contractor, that has a substantial interest in the preparation, negotiation, or approval of the CRADA is held by any person or organization with whom such employee is negotiating or has any arrangement concerning prospective employment.

2. The Contractor shall require that each employee of the Contractor who has a substantial role (including an advisory role) in the preparation, negotiation, or approval of a CRADA certify through the Contractor to the Contracting Officer that the circumstances described in paragraph 1. above do not apply to that employee.

3. The requirements of paragraphs 1. and 2. above shall not apply in a case where the Contracting Officer is advised by the Contractor in advance of the participation of an employee described in those paragraphs in the preparation, negotiation or approval of a CRADA of the nature of and extent of any financial interest described in paragraph 1., and the Contracting Officer determines that such financial interest is not so substantial as to be considered likely to affect the integrity of the Contractor employee's participation in the process of preparing, negotiating, or approving the CRADA.

III. TECHNOLOGY TRANSFER IN OTHER COST SHARING AGREEMENTS

In conducting research and development activities in cost shared agreements not covered by Section II. above, the Contractor, with written permission of the Contracting Officer, may provide for the withholding of data produced thereunder in accordance with the applicable provisions of paragraph II.C. herein.

(Appendix C)

DEPARTMENT OF ENERGY ORDER 5000.4

Date: February 28, 1991

Subject: Laboratory Directed Research and Development

1. PURPOSE. To establish the Department's policy and guidelines regarding Laboratory Directed Research and Development (LDRD) at its multiprogram laboratories.

2. RELATIONSHIP TO DOE 5000.1A. This Order supersedes the provisions of DOE 5000.1A. INSTITUTIONAL PLANNING BY MULTIPROGRAM LABORATORIES, of 9-12-86, pertaining to Exploratory Research and Development (ER&D). DOE 5000.1A will be revised accordingly.

3. SCOPE. The provisions of this Order apply to all Departmental Elements which direct, monitor, or utilize the Department's multiprogram laboratories and to the contractors operating these laboratories for the Department, as provided by law and/or contract, and as implemented by the appropriate contracting officer.

4. BACKGROUND. Independent and internal reviews of the DOE multiprogram laboratory system have consistently recommended that the laboratory directors be

allowed flexibility to select and conduct a limited number of research and development projects to exploit creative and innovative concepts. Such discretionary research and development is critical in maintaining the scientific excellence and vitality of the laboratories. Reviews have suggested that each laboratory should have a formal internal peer and/or scientific management review and selection process based on uniform Departmental criteria and guidelines which emphasize scientific and technological merit, and subject to adequate DOE oversight to ensure all funds are used appropriately.

5. REFERENCES.

a. DOE 5000.1A, INSTITUTIONAL PLANNING BY MULTIPROGRAM LABORATORIES, of 9-12-86, which establishes the policies and responsibilities for the Department's principal oversight process for Its multiprogram laboratories.

b. DOE 5000.2A, MULTIPROGRAM LABORATORY APPRAISALS, of 9-10-88, which establishes the policies and responsibilities for appraising the performance of the Department's multiprogram laboratories.

c. The Atomic Energy Act of 1954, as amended, 42 U.S.C. 2013, 2051, and 2053, which provides broad authority for research and development activities and their funding.

d. The Energy Reorganization Act of 1974, as amended, Public Law 93-438, 42 U.S.C. 5801(b), 5813 and 5817(a), which created the Energy Research and Development Administration (ERDA) to bring together and direct Federal activities relating to research and development on the various sources of energy and to carry out general basic research activities.

e. The Department of Energy Organization Act, as amended, Public Law 95-91, 42 U.S.C. 7111(4), 7112(5), which places the research and development activities formerly performed by the Atomic Energy Commission and ERDA under the Secretary of Energy, and directs the Department to carry out the planning, support and management of a comprehensive energy research and development program.

f. An Act to authorize appropriations to the Energy Research and Development Administration for Fiscal Year 1977, Public Law 95-39, which provides specific authority so that the Director of a Government-owned, contractor-operated laboratory may use a reasonable amount of the laboratory's operating budget to fund employee-suggested projects up to the pilot stage of development, with the approval of the Secretary.

6. DEFINITIONS.

a. Laboratory Directed Research and Development (LDRD) is research and development work of a creative and innovative nature which is selected by the laboratory director, or his or her designee, for the purpose of maintaining the scientific and technological vitality of the laboratory and to respond to scientific and technology opportunities in conformance with the guidelines in this Order. This LDRD includes activities previously defined as ER&D as well as other discretionary research and development activities not provided for in a DOE program.

b. Cognizant Secretarial Officer is a Secretarial Officer responsible for management oversight of a multiprogram laboratory as delineated in DOE 5000.1A.

c. Laboratory Appraisal is an annual evaluation of multiprogram laboratory management performance conducted in accordance with DOE 5000.2A.

7. POLICY.

a. It is the policy of the Department to permit each multiprogram laboratory to carry out a limited amount of basic and applied research and development which focuses on early exploration and exploitation of creative and innovative concepts selected at the discretion of the laboratory director. The purpose of this policy is to enhance the ability of the laboratories to address the future mission objectives of the Department. This is accomplished by providing the laboratories with the flexibility to support new science and technology ideas to determine their worth and a mechanism which is a major factor in achieving and maintaining staff excellence. The LDRD program provides the multiprogram laboratories with an opportunity to fund new and highly innovative research activities.

b. The level of allowable funding which may be expended by each laboratory will be established annually in accordance with the requirements of this Order. However, the level so established shall not exceed an amount of operating funds equivalent to 6 percent of its total operating budget, including non-DOE funded work, for the year, plus an amount of capital equipment funds not to exceed 6 percent of its total capital equipment budget for the year. The system for accrual of these funds shall, to the extent reasonable, provide for equitable pro rata contributions by all sources of operating and capital equipment funding.

c. The annual level of LDRD funding will be based not only on how well the laboratory manages the LDRD program, but also on overall laboratory management performance.

d. The Department will exercise effective oversight of the laboratories' LDRD program and integrate review of the program with the Institutional Planning Process.

8. RESPONSIBILITIES AND AUTHORITIES.

a. The Secretary.

(1) Establishes the Department's policy on LDRD.

(2) Approves the laboratories' LDRD plans and the allowable funding levels recommended by the cognizant Secretarial Officers.

b. Director of Energy Research ensures that the LDRD program is integrated with the Institutional Planning Process which includes the multiprogram laboratory appraisal process. The Director carries out for the Office of the Secretary, or by request of the cognizant Secretarial Officer, periodic review of the LDRD policy and its implementation (in cooperation with appropriate Departmental Elements) and recommends revisions, as required.

c. Cognizant Secretarial Officers.

(1) Exercise general oversight of all activities related to LDRD at the laboratories for which they have cognizance.

(2) To ensure adequate compliance with the requirements of this Order, annually conduct a review, with the assistance of the appropriate Operations Office Manager, of each laboratory's LDRD activities, including each laboratory's LDRD management system, as well as the results of the program.

(3) Establish such additional procedures and/or guidelines as are required to fully and efficiently implement the requirements of this Order. These may be tailored to their Headquarters organizations, to the pertinent operations offices, and to the laboratories for which they have cognizance.

(4) Annually establish for each laboratory, a level of resources which may be expended on LDRD for the next fiscal year. The determination of this level will be based in part on a plan proposed and submitted by the laboratory director through the cognizant Operations Office Manager, and in part on the results of the most recent review of the laboratory's LDRD program.

The plan shall provide a general description and justification of the LDRD program, and explain how this program will meet laboratory needs, support the laboratory's mission, and benefit the Department and the Nation. Additionally, on the premise that the effectiveness of the LDRD program is forecast by the overall effectiveness of the laboratory's management, the determination will also be based on the most recent laboratory annual appraisal.

(5) Provide the laboratories' LDRD plans and the recommended maximum allowable funding levels and rationale to the Secretary for approval.

d. Managers of Operations Offices.

(1) Provide an evaluation of the laboratory's LDRD activities and processes to the cognizant Secretarial Officer and any other information, as necessary, to assist the cognizant Secretarial Officer in the annual review of each laboratory's LDRD program.

(2) Annually review and certify in writing to the cognizant Secretarial Officer that the laboratory's method for accumulating LDRD funds meets the requirements of this Order.

(3) Conduct such additional reviews of each laboratory's LDRD activities as are necessary to ensure that each laboratory is complying with the requirements of this Order as well as the requirements of the laboratory's LDRD management system.

9. LDRD GUIDELINES.

a. Selection of Projects. Each laboratory will establish a defined process, utilizing internal peer and/or scientific management review, with selection criteria which emphasize scientific and technological excellence. A significant portion of the projects selected should be those independently proposed by individual researchers or small multidisciplinary teams. As noted in paragraph 8d above, the Operations Office Manager will provide an evaluation of the laboratory's LDRD processes for review by the cognizant Secretarial Officer.

b. General Characteristics of LDRD Projects.

(1) Projects, normally relatively small, in the forefront areas of basic and applied science and technology for the primary purpose of enriching laboratory capabilities.

(2) Advanced study of new hypotheses, new concepts, or innovative approaches to scientific or technical problems.

(3) Experiments and analyses directed towards "proof of principle" or early determination of the utility of new scientific ideas.

(4) Conception and preliminary technical analysis of experimental facilities or devices.

c. Length of Projects. LDRD projects will normally have a maximum period of funding, e.g. 3 years, to be established by the laboratory director and incorporated in the laboratory's LDRD management process. Any exceptions to the established limit must be approved by the cognizant Secretarial Officer.

d. Appropriate LDRD Expenditures. LDRD expenditures shall be considered an allowable cost in accordance with the terms and conditions of the laboratory operating contract, and shall be identified in the laboratory accounting system. With the exception of the restrictions listed in paragraph 9e below, funding of LDRD projects may include all costs normally associated with similar research and development activities of the laboratory such as travel in direct support of a project, capital equipment in direct support of a project, or support for participation by non-laboratory personnel.

e. Restrictions. LDRD funds may not be used to:

(1) Substitute for or increase funding for any tasks for which a specific limitation has been established by Congress or the Department, or for any specific tasks that are funded by DOE or other users of the laboratory.

(2) Fund LDRD projects that will require the addition of non-LDRD funds in order to reach a useful stage of completion.

(3) Fund construction design beyond the preliminary phase (e.g. conceptual design, Title I design work, or any similar or more advanced design effort may not be supported).

(4) Fund construction line-item projects, in whole or in part.

(5) Fund capital expenditures of a general purpose nature with the exception of acquisition of general purpose equipment which is clearly required for the project and is not otherwise readily available from the laboratory inventory.

f. Reporting Requirement. Each laboratory shall submit an annual written report on its LDRD activities to the cognizant Secretarial Officer through the appropriate Operations Office Manager. The annual report shall include a technical and financial overview of the program, as well as a short summary of each funded project. Additionally, each laboratory will provide reports to the Office of Scientific and Technical Information.

Senator SHELBY. We appreciate your testimony.

I have a series of questions that I want to ask you for the record, and I will give them in writing to you. But I would like to touch on a couple just for the sake of brevity.

I understand that the DOE laboratories have the capabilities to support most, if not all, of these critical technologies, but how much money does the DOE spend directly on these technologies? How much do they spend?

Ms. LANGENFELD. We do not have our budget cross cut by the categories in the national critical technologies reports that we have been talking about. I can certainly provide it for the record.

[The infomation follows:]

A summary of the FY 92 funding requests ($millions) from this representative budget cross-cut is shown below:

Critical technology category	*Funding request*	*Percent of total*
Materials	$371.2	13
Manufacturing	128.0	4
Information and Communication	118.9	4
Biotechnology and Life Sciences	159.4	5
Aeronautics and Surface Transportation	164.4	6
Energy and Environment	1994.7	68
Energy: 1076.0 (54%)		
Environment: 918.7 (46%)		
Total	$2936.6	100

The programs listed in this summary account for approximately 56% of DOE's non-Defense R&D program budget. Not shown is $32 million in Defense Programs (much of which is in the area of advanced manufacturing) and $4.9 million in

Energy Research programs, both for direct support of technology transfer. Also not shown is $18.9 million in administrative support (outreach, patents, licensing) of technology transfer in DOE Laboratories.

As with any cross-cut, it was necessary to make a number of assumptions because many DOE programs fall into more than one category. For example, there are valid reasons to place "Transportation Materials R&D" under "Materials", or to place it under "Energy and Environment".

The border between a "Critical Technology" and a closely related supporting technology is not always clear, and different definitions would give different results in a cross-cut. In case of doubt about whether to include a program in this list, our approach was to refer simultaneously to the DOE FY 1992 budget request and to the Report of the National Critical Technologies Panel, and to omit the program unless a clear reason could be advanced to include it.

Ms. LANGENFELD. I can also right now give you a representative sample of one of those critical technologies areas.

Within the technology transfer program, for example, just to give you kind of a cross cut on that basis, our request for fiscal year 1992 in defense programs (DP) is $32 million and energy research (ER) is $4.9 million. Those are the funds that we have requested directly. In addition to that, though, we also have funds allocated through the overhead structure at the laboratories. Approximately $20 million to $22 million are also applied to technology transfer.

In terms of specific technology areas, the CRADA's, cooperative research and development agreements, do not necessarily require us to allocate new money. There are certain activities that do require increases in funding and those are the increases I just described.

But the CRADA is also a mechanism for increasing cooperation between industry and the labs on mission responsibilities we already have. For example, in high performance computing, we have performed that cross cut as part of the FCCSET committee process, and DOE's estimate for fiscal year 1992 is $93 million just in high performance computing. That does not include the other computing technologies that we develop and transfer as part of other mission responsibilities. That $93 million is out of a total of about $638 million for the Federal Government. That is an example of the magnitude of effort.

Senator SHELBY. What is the DOE doing to make known the resources that are available in the labs to industry, particularly to small and medium sized firms?

Ms. LANGENFELD. The outreach program for the Department of Energy and the programs in the laboratories is currently under some additional evolution. Each laboratory conducts an outreach program of its own, having industry workshops, for example. Oak Ridge just this week had an industry workshop on advanced manufacturing technologies specifically for small and medium sized firms. At the program office level, such as conservation and renewable energy (CE), they also support outreach activities and workshops.

We are increasingly doing more coordinated activities as the Department of Energy. For example, we will be participating in NASA's Technology 2001 in December, and at that time, DOE will have a location at Technology 2001 in addition to several of the laboratories. We are trying to coordinate those efforts to provide better visibility in terms of what the labs can do.

We also produce an annual report. This year's report is called Technology 90 which describes the technology transfer activities of the programs in the labs.

But we are looking at other ways of increasing awareness, reaching particularly small business and medium sized businesses more effectively, such as through working with State organizations and other mechanisms.

Senator SHELBY. As I told you, I have a series of questions that you said you will answer for the record.

Ms. LANGENFELD. I will be happy to.

Senator SHELBY. Senator Bingaman.

Senator BINGAMAN. Thank you very much, Mr. Chairman.

I am going to ask that we put a chart up here so I can just give you my own perspective of what we are trying to do with this legislation and be sure that you are in sync with our approach and can, at least, agree on where we are trying to head. This is a hard chart to read, especially from that distance I would assume.

But at any rate, let me just indicate what it is basically. We have across the top there OSTP and industry, and we also have a box representing each of the Federal agencies with a significant research and development budget: Department of Defense, Department of Commerce, Department of Energy, NASA, National Science Foundation, NIH, or Health and Human Services. That is described across the top.

Down the left-hand side, we have tried to begin listing those areas of technology development that the country needs to have a leadership role in. The first one on the list there, of course, is high performance computing because that is the one that OSTP, through the FCCSET process, organized first and developed a cross cut of the Federal budget. You indicated $93 million is DOE's part of that and, of course, that is what is shown there on the chart. The amount that each of the other agencies is committing to high performance computing is also up there.

What we are trying to do is to organize ourselves, as best we can, to be sure that we not only move ahead in high performance computing and development of that technology, but we do the same thing in the other areas that are of great significance to the country as they have been identified. Included on the chart are materials processing and manufacturing and I am sure there will be others.

What we are trying to do through this legislation is be sure that as the country moves ahead, and as the Federal agencies in particular move ahead, to organize themselves in pursuit of these technologies, that the DOE will not be behind the pack. I agree totally, of course, with your characterization of the great strengths the Department of Energy has, and I do believe that they bring more to the table probably than any other agency in many of these technologies because of the history of work that has been done both in the defense laboratories and the non-defense laboratories. But what we have tried to do in this legislation is to set up a organization or a framework under which DOE could better organize itself to systematically pursue development of these technologies as the other Federal agencies are doing the same thing.

So, that is all by way of preliminary information.

I would like to ask you a question. One of your comments was that your thought was that developing a plan to identify the information we are calling for here would be counterproductive to the effective management of the Nation's scientific and technological resources. I am not sure that I understand that.

Ms. LANGENFELD. In my written statement, we were trying to describe that a separate plan to focus on cutting our R&D budget and planning our R&D budget along a different dimension may not add value to the process. We agree that the national critical technologies reports are useful in helping us set the priorities, in evaluating our budgets, and preparing our budgets annually. We have an existing strategic planning process that drives our budgeting process, and we are using all the information that is available to us to try to remix our research and development portfolio, including technology transfer, to better meet the needs of the Nation.

The point we were trying to make is we already participate in the emerging technologies development that Commerce produces. We already participate in the national critical technologies panels. So, DOE's input is already represented in that report. And we already participate in the militarily critical technologies report done by DOD. The point we were trying to make, having another report from another agency was not necessarily going to help us to move forward toward meeting the goals. We would like to integrate this type of thinking into our current processes as much as possible.

Senator BINGAMAN. Do you now have cross cuts in the agency, for example, in manufacturing? Is there a single place in DOE that I could go to and find out the extent of the effort and in some detail the level of funding and all that DOE has committed to flexible manufacturing? That is one of the areas that is of particular significance for the Nation.

Ms. LANGENFELD. We have not done cross cuts on all the technologies at that level of detail. We could develop them and we hope to, as part of the fiscal year 1993 process, take a look at those cross cuts at least at the 6 major category areas if we cannot get down to 22 areas.

Senator BINGAMAN. And do you agree that that would be a useful thing to do those cross cuts in terms of looking at where DOE itself is in the development of these particular technologies?

Ms. LANGENFELD. We routinely perform a variety of cross cuts, and we think this would be a useful cross cut to look at in addition to the other information we use in our planning.

Senator BINGAMAN. Now, do you develop 5-year plans-in technology areas that describe where you are expected to go, what the milestones are, or what the level of funding you expect to need in each of these areas is?

Ms. LANGENFELD. As part of the strategic planning process, we have initiated multi-year program plans, which do go out 5 years. Last year was the first year of developing those multi-year program plans. The laboratories also have an institutional planning process where they also look at their individual core competencies and project what they plan to do within the laboratory. Part of our oversight is working with them on that institutional planning process.

Senator BINGAMAN. I guess what we are trying to require in this legislation is strategic planning around the technology areas in which we need to move ahead. It is not just strategic planning of particular programs or strategic planning of particular laboratories' activities on different things, but it is a coordinated strategic plan by all of the entities within DOE that are in pursuit of particular technologies. And that is, I think, where we are trying to go. But you see that perhaps as counterproductive, I gather from your testimony.

Ms. LANGENFELD. In terms of those specific organizational issues, we are already organized to perform those tasks. For example, in areas where research is performed in both Conservation and Renewable Energy, and Energy Research, there are internal committees that provide that coordination to ensure that the work that the different programs are conducting is coordinated. We would do the same in the environmental area. The Environmental Restoration area involves both DP and Office of Environmental Restoration and Waste Management (EM). So, we do already have a significant level of coordination internally, as well as through the interagency process. We are also working on the advanced materials cross cut that OSTP is developing right now as well. So, the point was not so much that we did not agree with the organizational needs, only that we believe we are already doing most of those things and have the mechanisms in place to facilitate it without creating new mechanisms to do that.

Senator BINGAMAN. Let me get out one other issue here. The CRADA's that were provided for in the Act, that you have referred to that Senator Domenici and I worked on before, do not provide for the expenditure of DOE funds to industry R&D directly. Am I right in that?

Ms. LANGENFELD. Not for 100 percent industry-driven R&D, if that is what you mean.

Senator BINGAMAN. They provide for cooperation where a national laboratory or some element in DOE will work jointly with industry on a project, but you do not have funds that you then allocate to industry to pursue a particular technology area.

Ms. LANGENFELD. Well, the CRADA's do not have a funds out component. So, that is correct. They are restricted from that.

Senator BINGAMAN. My own perception of what we are talking about here in the partnerships that we call for in this legislation is that "partnerships" is a more generic term than CRADA's. CRADA's are one type of partnership. There are other types of partnership. For example, what we have done in DARPA this year is to provide $50 million for them to use for this generic precompetitive technology development, and they are then using those funds as grants to industry consortia to work. DARPA involves itself and in some cases, other Federal laboratories also. But essentially they do have a funding capability in areas that industry identifies as important.

I guess what we are saying is that in my view at least, it would be very useful for the Department of Energy to also have a funding mechanism and to also have the capability to work with industry in ways that are in addition to those activities focused on entering into CRADA's.

Ms. LANGENFELD. I believe we, again, already have those funding mechanisms. We started talking primarily about the CRADA's, but prior to the CRADA legislation, we were already doing cost-shared collaborative agreements in a variety of areas, both with the labs and directly with industry. For example, the specialty metals processing consortium is not a CRADA. It is a cost-shared agreement, and under that agreement it could have been constructed so that there was a component that was funds out. We have the tools available to us to accomplish the partnerships as they have been described in S. 979.

We also are able to support research that is of extreme interest to industry. Again, if you take the Conservation and Renewable Energy program as an example, we tend to think of them mostly doing things like solar research, but there is a significant component of that research that is in energy efficiency looking at materials that could be produced with less energy consumption, looking at manufacturing processes, such as the steel initiative, which we have authority to do. In those, there is a big component of industry-driven research agenda, and the objective is not only to improve energy efficiency, but the bottom line is to improve the competitiveness of those industries, since energy is such a big component of their costs.

Senator BINGAMAN. Since I have you here, let me just ask about the status of CRADA's. How many of them have been completed and signed off on?

Ms. LANGENFELD. We have, as of today, 22 CRADA's completely approved and in progress. There have been another 15 joint work statements presented to the operations offices. Most of those have been approved. Some are still under review. There are another 20 to 25 discussions between the laboratories and industry which are kind of the early stages of a joint work statement development that have not yet been provided to the operations offices for approval. All told, it is somewhere over 60 based on the estimates we receive from the laboratories.

Senator BINGAMAN. You know that is not consistent with the other information I received. I do not know, but my understanding is that Sandia has just completed signing off on its first CRADA. Los Alamos has one in place. Am I wrong about this? Am I getting bad information?

We had Mr. Claytor before the Armed Services Committee in the second week in April. At that time I told him that my understanding was we had one that had been completed, and he generally agreed.

Ms. LANGENFELD. We have one at Argonne National Lab, four at EG&G Idaho, two at Los Alamos approved, three at Oak Ridge National Lab, plus an additional I believe it is four at the Y-12 facility in Oak Ridge, one at the Solar Energy Research Institute. And you are correct. Sandia does not yet have an approved CRADA.

[Subsequent to the hearing, Ms. Langenfeld submitted the following:]

Subsequent review determined that the actual number of approved CRADAs at Y-12 at the time of the testimony was two.

Senator **Bingaman**. Well, that is a significant improvement over what I think he testified to in April then. I guess you have signed a great many since April.

Ms. **Langenfeld**. It is growing rapidly.

Senator **Bingaman**. Well, that is good. I am glad to hear that.

Ms. **Langenfeld**. We are getting the bugs out of the system too and shortening the time a great deal.

Senator **Bingaman**. I am very glad to hear that. That is good news.

Mr. Chairman, I have taken more than my share of time. Thank you.

Senator **Shelby**. We have been joined by Senator Domenici. Senator Domenici, if you have a written statement, it will be made part of the record. Otherwise, I will recognize you.

Senator **Domenici**. Thank you very much, Mr. Chairman. I have no written statement, and I will not take a lot of time because, obviously, you have a number of witnesses.

Let me ask so I will kind of understand. The Department of Energy technically speaking concurs that the national critical technologies are, indeed, that. Is that right?

Ms. **Langenfeld**. We agree that the national critical technologies reports and the priorities that they——

Senator **Domenici**. Establish.

Ms. **Langenfeld** [continuing]. Communicate are useful for helping us set our R&D priorities.

Senator **Domenici**. Let me ask it another way because I think what Senator Bingaman and I, as his cosponsor, have in mind—at least from my standpoint, I am not interested in what we can disagree on. I am interested in what we can agree on and then see if we can put a bill together that does this. It seems to me that you are not quibbling about whether the national critical technologies are relevant in terms of America's future. They are important and things ought to be happening in those areas if we want to remain competitive. Is that correct?

Ms. **Langenfeld**. That is correct.

Senator **Domenici**. And you also agree that, while not exclusively, that the Department of Energy is or should be involved in some or all of these technologies. Is that correct?

Ms. **Langenfeld**. I agree that we should be involved in some. I would not say at this point that we should be in all.

Senator **Domenici**. Yes. I think I said some or all. Is that a fair statement?

[No response.]

Senator **Domenici**. Well, okay. When you use "or", I thought you could choose which of the two, and so we agree. But maybe you are understanding my "or" to be "and".

Ms. **Langenfeld**. I am trying to respect the responsibilities of my sister agencies who also have significant responsibilities in a number of these areas.

Senator **Domenici**. Now, what concerns me—and frankly, I hope we can work something out, and I think I understand some of your concerns. But frankly, if I were the lab director at—pick one—Livermore, one of your major laboratories, and assume there was no inhibition on that laboratory being involved in some of this, and their great flexibility developed over many, many years and their tremendously versatile scientists could, indeed, do something in these areas with someone in America, another laboratory or a business, it would seem to me that as director, I would be interested in knowing, "What does the Department of Energy, as the national representative, expect of me in that area?" I might even be saying if I want to ask my scientists for some ideas so that we could work in the information and communications area, how do I find out whether the Department of Energy is genuinely interested in us doing it or not now without a bill like this.

Ms. LANGENFELD. Without the bill like that——

Senator DOMENICI. And there is no bill. We have not passed this bill.

Ms. LANGENFELD. There are a number of mechanisms in place that are used exactly for that purpose. The institutional planning process is the formal once a year process for the labs to identify the areas of research that they would like to pursue, the core competencies that they would like to build, and their proposals for how they will do that. And that process is a very important part. It has been in place for 10 years, and it has been improving every year in terms of its effectiveness.

In addition to that, there is the ability of the laboratory directed research and development, and those funds are available to the lab directors to use at their discretion again to explore new areas of science and technology and expand their capabilities prior to the point that a technology is going to go into a more technology transfer oriented type of project.

Then through the technology transfer program, we have not restricted that program to only be transferring technologies that come directly out of the research. That program is available for any technology or knowledge base within the labs, assuming that there is an interested outside participant and assuming that we can make the funding available.

What we are finding is that through our normal program funds and our set of missions, we have a great deal of flexibility to provide funding. Sometimes it may come out CE. Sometimes it may come out of energy research, and it may not be directly related to their specific missions. Energy Research, for example, has funds specifically available to support CRADA's that could be in any technology area.

Senator DOMENICI. Yes, I understand that. What I really am getting at—see, this fellow back with the white beard behind you runs one of the labs.

Ms. LANGENFELD. Yes, I know him.

Senator DOMENICI. And the other one is not here in our State, but Senator Bingaman and I see them all the time.

Ms. LANGENFELD. Yes.

Senator DOMENICI. Right now as they are moving in transition and trying to use their great laboratory strength in things that will help the country—I am not speaking for them, but my observation is that they are very worried about what they should be doing. I honestly believe that. Where should they be looking for roles, activities with the private sector that help their country? And they really are very, very loyal. It is almost like, "How can we help our country?"

Frankly, it seems to me that it would serve some useful purpose if we had some very significant—and I do not know that we need all these things that are in this bill—goals and objectives right up front that the Secretary could say we really want to emphasize these eight things. Is there anything wrong with that attitude?

Ms. **LANGENFELD**. I would not disagree with that at all.

Our problem with this bill, as it is currently written, is it does not provide that kind of guidance. It refers to 3 critical technologies reports, 22 technologies in one, another 23 in another, and overlaps between them. That really is very difficult to help establish any guidance. It is useful information for helping us evaluate priorities. In a horse race between two CRADA's, for example, I would hope we are funding one that was identified in one of the critical technologies reports as opposed to a technology that was not. And I would hope that the laboratories would do that in their planning and that our programs are doing it in their planning.

But the broad brush approach of S. 979, in trying to read it and think about how we would apply it, it was difficult to really read it in a way that it gave us additional guidance. There were some mechanical problems with it that we felt would dilute our other efforts. So, we would like to work with you on the true needs of solving the problems that we have remaining.

Senator **DOMENICI**. Well, I appreciate your last remarks. Frankly, I think I am being as honest and as forthright as I can be.

I want to just make one other observation with reference to these great laboratories. Frankly, I really do believe they are that, and there are a lot of them. It seems to me that we have to begin to find a way to measure their effectiveness. I am not at all sure that this bill provides the exact mechanism, but in a sense if you have defined goals, it seems like you can report to somebody rather regularly, you or the Admiral, that you have achieved some things.

Why do I say that? I say that because we are spending a lot of money and we are not a business. So, we do not have a profit and loss statement. We do not have a lot of happy employees with pension plans that the profit and loss paid for. We have to find some way to tell America we are succeeding.

Ms. **LANGENFELD**. We agree.

Senator **DOMENICI**. Otherwise, I am very fearful that we are not going to be able to have Congress keep paying for these things. This is not so easy in technology transfer in its broadest sense. I am kind of concerned that if we do not set some goals and then at times measure and be able to take credit for what really is going on, that it will be hard to keep the level of effort. Maybe this is not exactly the way, but something like it has to be in effect to do the measuring.

I thank you for your testimony.

Thank you, Mr. Chairman.

Senator **BINGAMAN** [presiding]. Senator Craig.

Senator **CRAIG**. Thank you very much, Mr. Chairman.

Cherri, I apologize for not being here to hear your testimony. I have had a chance to glance over it, and I am certainly aware of the context of the bill that the two Senators here have introduced.

Let me at least echo my concerns that I think have been effectively expressed by both of them. Certainly Senator Domenici expresses what I see as necessary whether it be for their laboratories or the laboratory in Idaho, goals, directions, measurable achievements, well beyond what have been some of their traditional roles that are now in transition and reexamination, which is certainly acceptable and is necessary based on budget considerations. But at the same time, I recognize not only the value of that laboratory in Idaho to Idaho, but to the Nation in the quality of work that it has done historically and the phenomenally high caliber of people that it has assembled there to do that work, the importance of that kind of work being transferred readily into the private sector, and the partnerships that you are talking about.

Your willingness to cooperate with us in whatever we can effectively craft here will be extremely valuable because down the road that partnership that keeps us out there in front of the rest of the world in a competitive way is one that I think needs to be enhanced. It is one that in the past we have stood apart, if you will, the Federal Government from the private sector, and in some instances, I suspect we cannot do that anymore nor should we. I think we have an unbelievably high level of capability with these laboratories to bring that together. So, working with us will be extremely valuable.

Let me compliment both of these Senators for the work they have already done. I do not know if it is the right work, but I know they out there pushing at the moment to make sure that something does happen. I am going to work with them to make sure it does so that we maintain equal and balanced and sensitive to all of the—what do we call it? The cores of competency I guess that exist within our laboratories and how we might use them effectively.

Ms. LANGENFELD. Well, the two Senators have certainly kept us on our toes. And I do not think we are disagreeing, again, on the objectives or where we want to be, where we want to go. I think we can work together in terms of the specifics of how we get there. But thank you for your comments.

Senator CRAIG. Thank you.

Senator BINGAMAN. Thank you very much.

Ms. LANGENFELD. If I could, Senator?

Senator BINGAMAN. Certainly, go ahead.

Ms. LANGENFELD. And if Al will let me do this. He just handed me a note while we were talking that said Signetics and DOE in Sandia just signed Sandia's first CRADA right when the hearing began. So, we will update the numbers to be one for Sandia.

Senator SHELBY. Good. Every time we have a hearing, we expect another one to be announced.

[Laughter.]

Ms. LANGENFELD. Congratulations.

Senator BINGAMAN. Thank you very much.

Why don't we go ahead with the next panel? Dr. Charles Shank, who is Director at Lawrence Berkeley Laboratory, and Dr. Al Narath, President at Sandia, if they would please come forward. Dr. Shank, why don't you go right ahead and give us your testimony? You can summarize it or do whatever you would like.

STATEMENT OF DR. CHARLES V. SHANK, DIRECTOR, LAWRENCE BERKELEY LABORATORY, BERKELEY, CA

Dr. SHANK. Mr. Chairman and members of the subcommittee, it is a pleasure to be here to discuss S. 979, the "Department of Energy Critical Technologies Act of 1991." To briefly introduce myself, I became the Director of the Lawrence Berkeley Laboratory in September 1989, having spent the previous 20 years at AT&T Bell Laboratories. I bring today the perspective of an industrial researcher tempered by my recent experience as the Director of LBL and a member of the Critical Technologies Panel.

The support of critical technologies can have a significant impact on the Nation's economy. Our world is becoming more competitive and dependent upon advanced technology every day. The ability of American industry to compete in the global marketplace and to provide high value-added American jobs is linked to our ability to provide leadership in these technological areas.

As a scientist whose instincts are still in industry while adjusting to the challenges and opportunities of a national laboratory, I believe that only the Federal Government and especially its national laboratories have the long-term perspective essential to assessing the Nation's future technological needs.

Our panel identified two critical technology areas particularly relevant to the capability of DOE and its laboratories and the proposals in S. 979.

The first area is materials synthesis and processing. In examining this field, perhaps the most exciting course for the future will be an opportunity to build new materials atom by atom. Rather than tailoring existing materials for a particular use, we envision engineering new materials with unique properties. From lighter, stronger construction materials to new medical technologies and new electronic devices, there will be no limit to the possibilities of these artificially engineered materials.

The excitement in this field is rapidly spreading. A major initiative in materials synthesis and processing is under consideration for the fiscal year 1993 budget. Materials synthesis and processing has, however, had a hard time finding an intellectual home in American universities. Yet, it requires the tools and the approach of fundamental science. For this reason, there is a special role for the Department of Energy national laboratories which have considerable experience in long-range materials research and unique facilities available to the broader scientific community.

The second closely related technology field is micro and nanofabrication. Perhaps the most widely recognized need in this area is fabrication of the next generation of semiconductor chips. This is a field in its infancy with much to be learned about constructing devices the size of hundreds of angstroms of atoms.

One promising area of research is the use of X-rays for fabricating denser integrated circuits. Research and X-ray lithography is proceeding at a rather measured pace in this country considering its importance to our investment in the semiconductor industry and competition for overseas. A promising new source of X-rays will be coming on line in 1993 at the Lawrence Berkeley Laboratory. The advanced light source will be the world's brightest source of so-called soft X-rays in the spectrum, ideal for X-ray lithography research. We are currently working with industrial and academic scientists on a program that will rapidly advance this field and retain our Nation's leading role in the world's semiconductor industry.

In addition to these areas, the panel identified six general areas of concern: materials, manufacturing, information and communications, biotechnology and life sciences, aeronautics and surface transportation, and energy and the environment. In order to explore the implications of national critical technologies report for the DOE laboratories, DOE's Office of Energy Research is sponsoring a workshop this fall at LBL.

Since World War II, the Federal Government has assumed the responsibility for supporting scientific research. The world is changing and support for technological research will be as important to our economic and national security as scientific research. I believe it is time to expand the Federal mission to include technology research.

What is missing from the Federal effort so far is support for fundamental civilian technology research within the Department of Energy. It is time for the Nation to obtain value from the DOE's massive investment in fundamental research at its national laboratories.

I was delighted to hear that you are proposing to amend S. 979 to include an office of energy research in DOE. I believe that such an office of energy research will have two effects that will benefit our Nation's economic competitiveness.

The first would be to address generic precompetitive technology research of long-term interest to American industry. This would support those technology research areas where DOE facilities have a particular expertise.

The second would have the specific goal of moving technological innovations into the private sector. The program would jointly fund cooperative research and development agreements, as well as support national laboratory projects where an advance in technology has occurred, but additional work is required before commercial applications can be identified. There is a small program within the DOE's Office of Energy Research that supports this work, but its proposed fiscal year 1992 budget is only $4.9 million. The Department of Energy and the Nation would greatly profit from a technology research program, and I am pleased to see that the Senate Appropriations Committee has provided $20 million for such a program in its fiscal year 1992 energy and water development bill.

S. 979 would go a long way toward supporting the research essential to the technological future of our Nation. I do have three specific comments on the legislation.

First, the third finding in section 2 refers to full utilization of the capabilities of the DOE national laboratories to enhance United States national security and economic competitiveness. I do not believe anyone could successfully argue that the laboratories are being fully utilized in these efforts. It is precisely the lack of DOE support for technological research efforts outside their traditional programs that requires a technology research program.

Second, with respect to the definition of Department of Energy critical technology, it is important to broaden the Department of Energy's traditional mission to include those areas where the laboratory's facilities and expertise can be used for the overall benefit of the Nation. As defined in section 4, a critical technology requires that a Department of Energy laboratory demonstrate broad technological competence in the area. This definition would provide sufficient breadth to address not only the DOE's specific needs, but the broader requirements of the economy.

My third comment pertains to the partnership proposals in section 202 of the legislation. Many of the Department of Energy national laboratories are already involved in research partnerships with industrial firms through existing agreements on proposed cooperative research and development agreements. This program would accelerate the establishment of these relationships. However, requiring a 50 percent cost-sharing of these projects by non-Federal participants will present a serious obstacle. With the typically short investment horizon of industry, there will be a great reluctance to participate in long-term, generic technology research required in some areas. What may result are partnerships focused on short-term projects and payoffs while long-term technologies are neglected. I strongly recommend that this section of S. 979 be modified to produce more flexibility for industry contributions to these research efforts.

In closing, Mr. Chairman, it is a pleasure to support the philosophy and the concepts that underlie S. 979. Our panel was hoping to provide you and your colleagues with a road map of where we should go and legislation like S. 979 will certainly move us down the road to a sounder, stronger technological future.

[The prepared statement of Dr. Shank follows:]

PREPARED STATEMENT OF DR. CHARLES V. SHANK, DIRECTOR, LAWRENCE BERKELEY LABORATORY, BERKELEY, CA

Mr. Chairman and members of the Subcommittee, it is a pleasure to be here today to discuss S. 979, the Department of Energy Critical Technologies Act of 1991. To briefly introduce myself, I became the director of Lawrence Berkeley Laboratory (LBL) in September, 1989, having spent the previous twenty years at the AT&T Bell Laboratories. When I left, I was director of its Electronics Research Laboratory. My own research field is the study of ultrafast processes with short pulse lasers, work that has resulted in specific new technologies and a number of patents. The views that I express today will have the perspective of an industrial researcher tempered by my more recent experience as a Department of Energy national laboratory director and a member of the National Critical Technologies Panel, which recently issued its report to the President and the Congress.

The identification and support of critical technologies can have a significant impact on the nation's economy. Our world is becoming more competitive and more dependent upon advanced technology every day. The ability of American industry to compete in the global marketplace, and to provide high value-added, high technology American jobs, is inexorably linked to our expertise and ability to provide leadership in these critical technological areas.

As in any policy debate, there are those who argue that these concerns and decisions should remain in the private sector, and that the Federal Government should remain on the sidelines during this battle. As a scientist whose instincts are still in industry while adjusting to the challenges and opportunities of a national laboratory, I believe that only the Federal Government, and especially the national laboratories, has the long-term perspective essential to assessing the nation's technological needs for the future.

As I mentioned before, I came to the Panel and the issue of critical technologies with a rather unique distinct perspective—no longer an industrial researcher, and just beginning my tenure as director of LBL. This provided me with an in-depth understanding of the needs and opportunities in the industrial research sector, combined with an emerging view of how the Federal Government can most effectively enhance the country's technological strength.

The Panel identified two critical technology areas which I believe are particularly relevant to the capabilities of DOE and its laboratories and the proposals in the legislation before the Committee. I want to discuss some specifics of these technologies, why the Panel included them, and my perspective on the proper Federal role in accelerating American research and development in these areas through its national laboratories.

The first technological area is materials synthesis and processing. The report defines synthesis as the development of new materials or new techniques to produce existing materials, and processing as the preparation of these materials into finished products. Synthesis and processing of materials can be viewed as a continuum of research rather than as two separate and distinct activities, for it is often the structure of the materials that ultimately determines how they will be processed and formed into a product.

In examining this field, perhaps the most exciting course for the future will be the opportunity to create new materials at the atomic level—literally to build atom by atom. Rather than tailoring existing materials for a particular use, we envision engineering new materials with unique properties. By modifying material structure we can tailor the electronic, structural, optical, magnetic, thermal or almost any property we desire. The applications of these materials will be as wide-ranging as the imagination. From lighter, stronger construction materials to new medical technologies, and new electronic devices—there will be no limit to the possibilities of these artificially engineered materials.

The excitement in this field is rapidly spreading. A major initiative in materials synthesis and processing is under consideration for inclusion in the FY 1993 budget. An increase in Federal support for this fundamental area of research could have major impacts on American materials competitiveness. To quote the Panel's report, "U.S. scientists traditionally have concentrated their studies on the properties of novel materials rather than on their synthesis, which has often been left to foreign laboratories", materials synthesis and processing has had a hard time finding an intellectual and academic home in American research universities. Yet it requires the tools and approach of fundamental science and a long-term commitment. For this reason, there will be a special role in this initiative for the Department of Energy national laboratories, which have considerable experience in long-range materials research and unique facilities that are already available to the broader scientific community.

At the Lawrence Berkeley Laboratory, we have been working at the forefront of new materials research for many years. At the Center for Advanced Materials, scientists work on materials ranging from high temperature superconductors to ceramics and semiconductors, with ongoing guidance from industrial advisory boards. They have at their disposal, as does the nation, the National Center for Electron Microscopy. This Center contains the most powerful electron microscope in the United States, and the highest resolution microscope in the world. The latter microscope, the Atomic Resolution Microscope, can actually image individual columns of atoms and allow differentiation between types of atoms. This kind of imaging is essential to future advances in both materials processing and synthesis. The Department of Energy national laboratories have a long-range research perspective in this area and a wealth of basic expertise which can be used to accelerate this initiative.

The second, and closely related, critical technology I want to address is the field of micro- and nanofabrication. The Panel's report describes this field as fabricating and manipulating materials at the microscopic and atomic level. Perhaps the most widely recognized need in this area is fabrication of the next generation of semiconductor chips, where the goal is increasing the density of components and thus a number of functions on the chip. Beyond the integrated circuit, there is a world of potential uses for nanofabrication, including biotechnology and optical electronics.

This is a field in its infancy, with much yet to be learned about constructing devices which have a size of a few hundred atoms. One promising area of research is the use of x-rays with very short wavelengths for fabricating denser integrated circuits. Research into x-ray lithography is proceeding at a rather measured pace in this country, considering its importance to our nation's investment in the semiconductor industry and the competition from overseas. A promising new source of x-rays will be coming on-line in 1993 at the Lawrence Berkeley Laboratory. The Advanced Light Source will be the world's brightest source of so-called "soft" x-rays in the spectrum ideal for x-ray lithography research. We are currently working with industrial and academic scientists to design a program that will rapidly advance this field and retain our nation's leading role in the world semiconductor industry.

This initiative, in collaboration with industry, universities, and other national laboratories, would develop an integrated system for research into the industrial use of projection x-ray lithography for integrated circuit production. It would provide specific x-ray beamlines for assessing optical component performance and evaluating advanced lithographic techniques. The initiative would also establish an in-house capability for nanostructure patterning, synthesis, and processing. These capabilities, and the resulting technologies, will have both defense and civilian applications.

Micro- and nanofabrication, however, is more than the next generation of semiconductor chips. Expertise in physics, chemistry, materials science, and electrical engineering needs to be strengthened and encouraged to explore the world of reduced dimensionality for all types of devices and processes. This is where this research field coincides with the critical technological area of materials synthesis and processing. Our national research agenda must cover the spectrum from a fundamental understanding of new materials and devices at the atomic level, to their eventual fabrication and mass production.

In addition to these areas, the Panel report identified six general areas of concern: Materials, Manufacturing, Information and Communications, Biotechnology and Life Sciences, Aeronautics and Surface Transportation and Energy and Environment. The DOE laboratories as a group have demonstrated competencies in all of these areas. They can be used to develop these technologies in concert with industry, both for the Department's energy and environment missions but also for the broader mission given the Department in the National Competitiveness Technology Transfer Act of 1989. In order to explore further the implications of the National Critical Technologies Panel report for the DOE laboratories, the DOE Office of Energy Research is sponsoring a workshop this fall at the Lawrence Berkeley Laboratory. The workshop will involve representatives from the laboratories, universities, industries, DOE and the Congress to examine the DOE competencies in these critical technology areas and the best means by which to exploit these competencies for the overall good of the nation.

In my opening remarks, I mentioned that I wanted to address what our nation could do to advance research on, and eventual application of, these critical technologies. For most, if not all, of these areas, the Federal Government has an important role to play in supporting this research. Despite the eventual industrial applications, the short-term view of industrial investment combined with the declining state of our economy precludes industrial financial involvement in the early stages of this fundamental research. Since World War II, the Federal Government has assumed the responsibility for supporting basic scientific research in our nation. The world is changing, and support for basic technological research will be as important to our economic and national security future as basic scientific research. It is time to expand the Federal mission to include basic technological research.

When this subject arises, many people use DARPA as an outstanding example of directed technological research for our national defense, and urge that a civilian DARPA be created. While DARPA has done a great job for the defense sector, and has resulted in many civilian applications, I believe that the Federal Government would be more successful in supporting civilian technology research expertise wherever it exists in its agencies. The Department of Commerce has the Advanced Technology Program, the National Science Foundation its Science and Technology Centers, and the Department of Agriculture its Agriculture Extension Services.

What is missing is support for fundamental civilian technology research within the Department of Energy. The Defense Programs portion of DOE has a program on Technology Commercialization whose FY 1992 budget proposal is $32.4 million. From my understanding of the program, however, it is designed to facilitate commercialization of technologies already developed through the weapons research laboratories. It is time for the nation to obtain value from the Department of Energy's massive investment in fundamental research at its national laboratories. What I have proposed for the Office of Energy Research in DOE and its laboratories is a Technology Research program that would support two complementary efforts with broad benefit to our national economic competitiveness.

The first effort would address generic, pre-competitive technology research of long-term interest to American industry. This program would support those critical technology research areas where DOE facilities had a particular expertise. These multi-year projects would be expected to have some level of industrial participation, such as advisory committees and boards, exchanges of scientists or contributions of funding, equipment or materials.

The second effort would have the specific goal of moving technological innovations into the private sector. This program would jointly fund Cooperative Research and Development Agreements (CRADAs), as well as support national laboratory projects where an initial technology has been developed, a clear market opportunity exists, but additional work is required before an industrial investor is identified. There is a small program within DOE's Office of Energy Research that supports this work, the R&D Laboratory Technology Transfer program, but its proposed FY 1992 budget is only $4.9 million. I believe that the Department of Energy, and the nation, would greatly profit from a Technology Research program, and I am pleased to see that the Senate Appropriations Committee has provided $20 million for such a program in its FY 1992 Energy and Water Development bill.

In examining S. 979, I believe that overall it would go a long way towards supporting the critical technology research so essential to the technological future of our nation. I do have three specific comments to make about the legislation. The third finding in Section 2 of the bill refers to full utilization of the capabilities of the DOE national laboratories to enhance United States national security and economic competitiveness interests. I strongly support this finding, but I do not believe that anyone could successfully argue that the laboratories capabilities are being fully utilized in these efforts. It is precisely the lack of DOE support for technological research efforts outside of their traditional programs that requires a Technology Research program and legislation like S. 979.

With respect to the definition of "Department of Energy critical technology", it is important that it broaden beyond the Department's traditional mission those technological areas in which the laboratory's expertise can be used for the overall benefit of the nation. As defined in Section 4, a critical technology requires that a Department of Energy laboratory demonstrate broad technological competence in the area. This definition should provide sufficient breadth to address not only DOE specific needs but also meet the broader requirements of the economy.

My third comment pertains to the Partnership Proposals established in Section 202 of the legislation. Many of the Department of Energy national laboratories are already involved in research partnerships with industrial firms through existing agreements or proposed Cooperative Research and Development Agreements (CRADAs), and this program could accelerate the establishment of these relationships. However, the requirement for a 50 percent cost-sharing of these projects by the non-Federal participants will present a serious obstacle. With the typically short investment horizon of industry, I believe there will be a great reluctance to participate in the long-term, generic technology research required by some critical technology areas. What may result are partnerships focused on short-term projects and pay-offs, while the long-term critical technologies are neglected. I strongly recommend that this section of S. 979 be modified to provide more flexibility for industry contributions to critical technology research efforts.

In closing, Mr. Chairman, it is a pleasure to support the philosophy and concepts that underlie S. 979. It is truly a critical time, both for these technological areas and for our nation. There are difficult decisions to be made about our future economic course. Our panel was hoping to provide you and your colleagues with a roadmap of where we should go, and legislation like S. 979 would certainly move us down that road to a sounder, stronger technological future.

Thank you.

Senator BINGAMAN. Thank you very much.

Dr. Narath, why do you not go ahead?

STATEMENT OF DR. A. NARATH, PRESIDENT, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NM

Dr. NARATH. Mr. Chairman, I am Al Narath, President of Sandia National Labs. With your permission, I would like to enter into the record my statement, and I will limit my remarks to a summary.

Senator BINGAMAN. We will be glad to include your statement.

Dr. NARATH. I am certainly grateful for this opportunity to address issues which I believe to be of vital importance to the DOE laboratory complex in general and to Sandia in particular.

S. 979 would focus technology transfer on topics associated with the technologies that are critical to national security and national economic competitiveness. This bill would authorize needed additional funding to support laboratory/industry cooperation in those critical technology areas.

My own views on this bill have been shaped strongly by the following set of beliefs.

In the first place, I believe that it is critically important that the United States remain both scientifically and technologically strong.

Second, I believe that the Nation must concentrate its resources in areas of greatest potential leverage.

Third, I believe that this leverage can only be achieved if we accelerate the translation of new technical insights into commercial products and services, products and services that meet the needs of global markets.

And fourth, I very strongly believe that the DOE labs can and must play an important role in this process, but can do so only through enhanced and improved teaming and partnering arrangements with the private sector.

Since speed and efficiency of process are critical, I suggest that it is important that any new legislation in this area build on existing statutes and employ processes which are already in place. In particular, it is important that this bill in its final form further the aims of the National Competitive Technology Transfer Act, NCTTA, of 1989. It is also important that it make use of the cooperative research and development agreement, CRADA, process to the extent possible.

I probably do not need to remind you that Sandia has a long history in the area of technology transfer. We have worked closely with American industry throughout the many years. We have be engaged in nuclear weapon research with industry. The pace of our industrial interactions picked up back in the 1970's when we entered the field of energy research and development. We are currently committed to greatly expanding the scope and speed of our technology transfer efforts, particularly to those parts of industry who own primary responsibility for working the national industrial competitiveness issues.

It is clear that S. 979 recognizes that the national interest can best be served if we prioritize laboratory/industry interactions according to critical technology needs. This bill provides the means and the incentive to the labs and to industry to act on the NCTP conclusions by learning to utilize DOE laboratory technology more effectively than in the past. I refer specifically to the funding authorization for critical technology partnerships. New funding authorization is particularly critical because at present, the government's cost-sharing funds for CRADA's must come from budgets that are already severely constrained. The budgetary support necessary to sustain the technology base at the weapons labs, for example, has been declining at an alarming rate. Supplementary funding of the type authorized in this bill could help reverse this decline while simultaneously supporting the development of technology for use to industry.

I might add at this point that I am particularly enthusiastic about the potential of realizing dual use of technologies, which is to say, much of our technology base at Sandia grew up as part of our weapons program. We now see opportunities for applying that same technology in the commercial sector.

At present, the Department of Energy and all of its laboratories are working very hard to refine the CRADA process to avoid delays that might in the future have an inhibiting effect on the formation of industry/laboratory partnerships. For this reason, it is important to state that fact again that any new legislation not encumber the CRADA process further by adding constraints or complicating the path from conception to approval. For that reason, even though we agree with the principle of 50 percent industry contribution, I have some concern that if applied to rigidly, a 50-percent requirement may discourage some potentially fruitful partnerships. A proposed CRADA which fully met the selection criteria spelled out in the bill but for which 50 percent industry funding could not be achieved might nevertheless be a better application of laboratory resources to urgent national needs than other alternative proposals. I therefore urge that some means of flexibility be provided, possibly in the form of waiver by the Secretary to deal with such potential conflicts between the 50-percent requirement and the goals of the bill.

Incidentally, I am pleased to note that Sandia's first CRADA involves an industry contribution which exceeds the 50-percent threshold.

A second concern I wish to raise relates to the time which may be consumed in the selection and approval process which the bill calls for. The speedy transition of technology from the R&D phase to products which can be taken to the marketplace is essential for U.S. economic competitiveness. If it is to be a model for future legislation affecting all Federal laboratories, this bill should do more than identify the right areas for laboratory/industry partnerships and encourage the formation of these partnerships. It should also enable selection and approval mechanisms which promote shorter cycle times from technology development to application. The selection criteria could, for example, explicitly acknowledge the importance of proposals that shorten cycle times. I believe there must also be assurances that selection and approval decisions will be made within a short time interval after a proposal is made so that alternative business plans can be put into action by industry partners if necessary.

In summary, I strongly support the intent of S. 979 as a logical step in further strengthening technology teamwork between U.S. industry and the DOE national laboratories. It builds on the U.S. technology policy as delineated by OSTP in September of 1990 and on the NCTP report of last March. Of course, the resources which the bill would provide to the DOE laboratories would make a significant contribution to our tech transfer efforts.

Thank you.

[The prepared statement of Dr. Narath follows:]

PREPARED STATEMENT OF DR. A. NARATH, PRESIDENT, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NM

Mr. Chairman, distinguished members of the committee, I am Al Narath, President of Sandia National Laboratories. I am grateful for this opportunity to comment on the DOE Critical Technologies bill because the bill addresses issues which are of vital importance to the DOE laboratory complex in general and to Sandia National Laboratories in particular. This bill constitutes another important contribution to the architecture of technology teamwork between U.S. industry and the DOE laboratories. The bill would focus technology transfer on topics associated with the technologies that are critical to national security and national economic competitiveness. The bill would authorize needed additional funding to support laboratory-industry cooperation in the critical technology areas. Furthermore, the bill is consistent with the policy set out in the OSTP document, "U.S. Technology Policy," of September, 1990.

It is important that legislation in this area build on existing statutes and employ processes which are already in place. In particular, it is important that this bill, in its final form, further the aims of the National Competitive Technology Transfer Act (NCTTA) of 1989. It is also important that it make use of the Cooperative Research and Development Agreement (CRADA) process, to the extent possible.

Congress first addressed the issue of technology transfer when it passed the Stevenson-Wydler Technology Innovation Act of 1980. This legislation was followed in 1986 by the Federal Technology Transfer Act. The 1986 law formalized the collaborative R&D process and authorized cooperative research and development contracts for the government's "government owned, government operated" (GOGO) laboratories and for certain "government-owned, contractor-operated" (GOCO) laboratories. At that time, the nuclear weapons defense laboratories were specifically excluded. The National Competitive Technology Transfer Act (NCTTA) of 1989 removed the exclusion, made technology transfer a formal mission for these laboratories, and allowed us to negotiate cooperative research and development agreements (CRADAs) with industry partners. This series of public laws has had the effect of enabling the creation of partnerships in which the technical resources of the federal laboratories could be harnessed to serve urgent national economic needs without compromising the core missions of those institutions.

More recently, the key departments of government, with the support of the Congress, have undertaken efforts to delineate those urgent needs which should serve as the targets for these partnerships between industry and the federal laboratories. These efforts have led to the preparation of critical technology lists, culminating in the release of the "Report of the National Critical Technologies Panel [NCTP]" in March 1991. The NCTP report drew two important conclusions which bear on the issue at hand:

> ". . . technology alone cannot ensure economic prosperity and national security. Technology can make an important contribution to the future of U.S. national interest, but only if we learn to utilize it more effectively."

The report goes on to identify 22 critical technologies, grouped into six main areas, which are critical to the national economic prosperity and to national security.

Because of the long-standing commitment of the DOE multi-program national laboratories to broadly defined national security missions, it should come as no surprise that the national laboratories already possess state-of-the-art capabilities in many of the critical technologies. The application of DOE laboratory core competencies to the development and industry utilization of the NCTP critical technologies is the unifying theme of this bill. The DOE weapons laboratories have the specific mission to provide the scientific and engineering foundation needed to sustain the U.S. nuclear weapon stockpile. The core competencies of the laboratories which sustain the nuclear mission will be stronger to the degree that they can be used to serve more than a single national need. Identifying dual uses or multiple uses for laboratory core competencies will allow us to broaden our base of support as well as provide the nation with a higher return on its investment in the national labs. The government and its laboratories cannot do everything for everybody. It is essential that we utilize tech transfer processes to focus laboratory competencies on the most critical areas where they can be effective.

The national interest can best be served if we prioritize laboratory-industry interactions according to critical technology needs. This bill provides the means and the incentive to the labs and to industry to act on the NCTP conclusions by learning to utilize DOE laboratory technology more effectively. I refer specifically to the funding authorization for critical technology partnerships. New funding authorization is particularly critical because at present the government's cost-sharing funds for CRADAs must come from budgets that are already severely constrained. The budgetary support necessary to sustain the technology base at the weapons laboratories, for example, has been declining at an alarming rate. Supplementary funding of the type authorized in this bill could help reverse this decline while simultaneously supporting the development of technology of use to industry.

Fundamental to our vision for technology teamwork between the DOE laboratories and industry is our firm belief that private industry must assume primary responsibility for solving the national competitiveness problems. Nonetheless, government policy should support the process rather than inhibit it. Legislation should encourage industry to finance more technology development on its own behalf. For example, according to recent studies, Japanese industry funds 69 percent of all industrial R&D, German industry funds 59 percent, but American industry funds only 36 percent. This bill encourages American industry to increase its proportional funding by offering access to DOE laboratory capabilities as partners who will match or exceed the government contribution. Many of the CRADAs which Sandia is negotiating with industry partners demonstrate that industry partners are willing to commit contributions that would qualify under this legislation.

DOE and its laboratories are working hard to refine the process to avoid delays that might in the future have an inhibiting effect on the formation of industry-laboratory partnerships. For this reason it is important that any new legislation not encumber the CRADA process further by adding constraints or complicating the path from conception to approval. For that reason, even though we agree with the principle of 50 percent industry contribution, I have some concern that if applied rigidly, a 50 percent requirement may discourage some potentially fruitful partnerships. A proposed CRADA which fully met the selection criteria spelled out in the bill but for which 50 percent industry funding could not be achieved might nevertheless be a better application of laboratory resources to urgent national needs than other alternative proposals. I therefore urge that some means of flexibility be provided, possibly in the form of waiver by the Secretary, to deal with such potential conflicts between the 50 percent requirement and the goals of the bill.

The second concern I wish to raise relates to the time which may be consumed in the selection and approval process which the bill calls for. The speedy transition of technology from the R&D phase to products which can be taken to the marketplace is essential for U.S. economic competitiveness. If it is to be a model for future legislation affecting all federal laboratories, this bill should do more than identify the right areas for laboratory-industry partnerships and encourage the formation of those partnerships. It should also provide selection and approval mechanisms which promote shorter cycle times from technology development to application. The selection criteria could explicitly acknowledge the importance of proposals that shorten cycle times. I believe there must also be assurances that selection and approval decisions will be made within a short time interval after a proposal is made so that alternative business plans can be put into action by industry partners if necessary.

In summary, I support the intent of Senate Bill 979 as a logical step in further strengthening technology teamwork between U.S. industry and the DOE national laboratories. It builds on the U.S. Technology Policy as delineated by OSTP in September 1990, and on the NCTP report of last March. The resources which the bill would provide to the DOE laboratories would make a significant contribution to our technology transfer efforts.

Senator SHELBY [presiding]. Thank you, Senator Bingaman.

I have a number of questions here—I believe there are 10 of them, very in-depth—that I would like to submit to both of you for the record and have you send that back to the committee where we can share it with the staff and the members of the committee. Would you gentlemen do this?

Dr. NARATH. I certainly will.

Dr. SHANK. I would be delighted.

Senator SHELBY. I thank you.

Do you have any other questions, Senator Bingaman?

Senator BINGAMAN. Yes. Mr. Chairman. Let me just ask a couple of questions.

One of the things that we do in this legislation is to establish or direct the Secretary to establish what we designate the Critical Technology Planning Council within the Department of Energy, the idea being that this would be a mechanism that over the long haul would continue to give attention to these areas and try to coordinate activities both within DOE and with other agencies. Dr. Shank, is there any such entity that is performing that function today? Is this something that would be a useful thing to establish? What are your thoughts on that?

Dr. SHANK. I think it would be very useful for the Department of Energy to have some kind of mechanism with which it could look at its facilities and its capabilities and plan how they might be best used to address the technological needs of the Nation. To my knowledge, there is not such a broad view that currently exists in the Department of Energy other than things that you heard about, our institutional planning process. But that institutional planning process is a cross cut of all activities within the laboratories and not just technology. I think looking at technology as a focus would be of value and useful in my view.

Senator SHELBY. Dr. Narath, did you have a thought on the value of establishing this kind of a council?

Dr. NARATH. I hope you will understand my reluctance to give you a straightforward, direct answer. I have enough trouble deciding the best ways of managing my own responsibilities without giving DOE advice how to manage theirs.

I will say from a Sandia perspective, ours has been over the years a very strong mission orientation. That mission orientation has led to the creation of a number of significant technical competencies. We are currently in the process of developing a deeper understanding of these competencies and the extent to which they relate to various critical technologies lists. We are driven by mission responsibilities. These have defined our involvement in critical technologies. Whether additional guidance from DOE as to Sandia's involvement in these technologies would be beneficial is a subject I would be happy to discuss with DOE.

Senator BINGAMAN. One of the things we had in mind and we pursued within the Armed Services Committee, both Senator Shelby and myself, is that we not only need to sort out where we stand in these critical technologies, but where we stand relative to other countries, the idea being that these are essential to our economic competitiveness and our national security needs. We need to constantly be monitoring the efforts of other countries in some of these areas so that we are knowledgeable about what they are doing and able to put our work into that perspective.

I have been concerned, very frankly, that there does not seem to be any significant thrust in the Department of Energy for this monitoring activity with regard to technologies overseas. We were in Japan last November, and my understanding is that DOE does have a science advisor or an employee in our embassy, but his full-time job is to try to persuade the Japanese to contribute to the support of the supercollider, which may or may not be a worthwhile thing for the Japanese to do. But we are not aggressively pursuing cooperation with them or even monitoring what they are doing in some of these areas. The reason I raise this issue in particular is that I think all of the panels, the one that you served on, Dr. Shank, and all of the others that have looked at these issues indicate that the Japanese lead us in some of the critical areas.

Am I right that we need to also have some mechanism or some entity within DOE focused on this monitoring of foreign technology development? Do you have a view on that, Dr. Shank?

Dr. SHANK. Well, I think that an international focus is extremely important. I think that realizing that all technology is not just in the United States—in fact, it is critical for our competitiveness—is very important. Precisely how that is done within the Department of Energy I guess I do not really know the answer to that, but I certainly think that it should be part of what we are all doing in terms of assessing what we are doing and how we are making decisions. So, I would encourage you in pursuing that area.

Senator BINGAMAN. Dr. Narath, did you have any thoughts about how that should be done or what is being done?

Dr. NARATH. I believe DOE is not alone in needing to sharpen its international vision. I believe our Nation is leaving a period during which it has been unchallenged economically, technologically, and otherwise, and that has led us to become somewhat arrogant. We need to learn that there are important developments taking place elsewhere in the world, developments that we should track very carefully for our benefit. I think all of us individually and collectively need to focus our sights more strongly on the rest of the world.

I might just add at this point that restricting participation in foreign technical exchanges, visits, attendance at conferences and so on I think is very poor economics.

Senator BINGAMAN. You mean restricting our own personnel's attendance at these?

Dr. NARATH. Yes.

Senator BINGAMAN. Is that what you are referring to?

Dr. NARATH. Yes. I recall in the early years of my scientific career seeing truly awesome numbers of foreigners attending our conferences, visiting our laboratories, learning a great deal. I think that is still ongoing. The reverse has generally not been the case, and it is something we need to pay attention to.

Senator BINGAMAN. I would just point out for the information of the witnesses that we have a proposal in the Armed Services Committee this year, which we hope to act favorably upon, which would earmark $5 million in the Department of Defense budget and $5 million in the Department of Energy defense programs budget for attention and investigation and pursuit of international cooperation and interchange in the area of flexible and advanced manufacturing in particular.

Dr. NARATH. I should also say that I believe that this process should not be a random process. Brownian motion will not get us there. I think it needs to be strongly targeted. We need to have specific interests in mind and pursue them, and then make sure that the information that we gain abroad is disseminated properly in our country.

Senator BINGAMAN. That is all I had, Mr. Chairman. Thank you all very much.

Senator SHELBY. Thank you, Senator Bingaman.

Gentlemen, I thank you on behalf of the committee.

Our next panel will be Dr. William A. Owczarski, Director of External Technology Development, United Technologies, and Dr. Alan Wilkes, Vice President, Chemical and Process Technology, Allied-Signal Companies. Gentlemen, if you would come up to the table.

Dr. Owczarski and Dr. Wilkes, on behalf of the committee, we welcome you here. Your written testimony, which you have brought with you, will be made part of the record. Dr. Owczarski, if you will start off and sum up orally your testimony, we will have a little time for questions. Thank you.

STATEMENT OF DR. WILLIAM A. OWCZARSKI, DIRECTOR, EXTERNAL TECHNOLOGY DEVELOPMENT, UNITED TECHNOLOGIES CORP., ON BEHALF OF THE NATIONAL ASSOCIATION OF MANUFACTURERS

Dr. **Owczarski**. Thank you, Mr. Chairman.

My capacity at United Technologies is Director of External Technology Development, which puts me in close proximity very frequently to many of the energy labs. I am also chairing the National Association of Manufacturers Technology Policy Task Force, and so I also represent them here in this afternoon's session.

I guess I could start by quoting from the findings portion of S. 979 and the quote is: "It is essential that the United States maintain a world leadership position in the development and application of technologies that are critical to national security and economic prosperity." This is certainly one principle that we can heartily endorse. In fact, in that spirit, we compliment you, Mr. Chairman, and the subcommittee on bringing the subject into the light of public debate. In particular, Senators Bingaman, Johnston, and Domenici deserve credit for their leadership in crafting S. 979 because it addresses some important approaches to the quest for this world leadership.

These approaches focus on the Department of Energy labs which have served our Nation so very well in their traditional missions and have developed an impressive array of engineering and scientific skills, as well as extraordinary equipment and physical facilities. As a company which is now engaged in collaborative research with several DOE labs, we can attest to the value of what we get from those interactions. In fact, I guess since we are involved with two of the CRADA's, I guess we represent over 10 percent of your customer base so far.

There are several main goals of S. 979 to sort of reiterate those in the context of the comments that I would like to make. First, to provide additional coordination and focus for the R&D activities of the laboratories, with emphasis on the recently identified critical technologies; second, to institute a DOE long-range planning process; and third, to produce plans supporting them fostering the commercialization of critical technologies through funded DOE lab, industry, and university partnerships. We certainly support all of these goals. If achieved, they can improve the process of Federal technology utilization by U.S. industry which is an important part of our competitiveness equation.

I would like to focus on just a couple of specific comments on this dimension of planning and partnership in the hope of stimulating some ideas and perhaps encouraging their implementation. I want to emphasize that I do so with the other perspective, namely that of the customer, or industry, as I do so.

The first comment is to agree with the fact that the development of a long-term plan is critical to success and so is the planning process to achieve it. The plan and the planning process at DOE must address a certain number of issues. First, the role and the missions of the DOE labs must be clearly defined. They are changing. Much of the defense and energy mission of their historical roles will stay, but the technology development in support of U.S. competitiveness is a new role and one which really should be articulated both inside the labs and to industry who is their new customer. They are cumulatively and individually large enterprises, and their missions warrant clear definition to assure that the investment they represent is effectively utilized.

In fulfilling these missions, particularly the new ones in support of industry and competitiveness, the DOE labs face many of the same challenges as corporate central R&D labs. I might use that experience as part of explaining what some of these ideas are.

First, in so doing, the DOE labs will only perform a small fraction of the total R&D that would eventually become involved in the commercialization of any technology. They should do that R&D in areas where they have unique capability and where they have the critical mass to make a difference. In that sense, S. 979 correctly addresses this point by fostering the emphasis on core competencies. No laboratory should try to do everything, and focusing on a few things that they do well is very important.

A second thought, as in case of corporate central labs, is that the DOE laboratory R&D agenda must be established in close consort with the customer. I use that in parentheses. The communication and credibility between a laboratory and its eventual user of technology form a critical factor in the success of any laboratory, whether it is DOE or in the private sector. This begins with selecting a relevant R&D agenda. The R&D agenda is very much, if I can use an analogy, like the decisions a grocer makes in stocking his shelves. After all, the product of the research is the commodity that that lab has to offer. He certainly has to know what his customer needs and stock his shelves accordingly to serve his customers effectively. Few grocers shelve just what they like and succeed accordingly.

R&D has to be customer-driven to be effective and highly useful. Successful corporate laboratories work very diligently to stay close to their customers to choose and then to execute the right agenda. The DOE labs certainly work closely with their traditional customers in the areas of weapons and energy programs and their models for planning R&D in these areas are successful. It will take new models to develop DOE laboratory R&D agendas for commercializable technologies. This is particularly true if we hope that this technology flow will occur in a cost effective and, even more importantly, a timely fashion. Timeliness is becoming as critical a factor in the competitive environment as anything else.

So, developing a model in which industrial needs are at least a portion of what drives the DOE lab R&D agenda must be addressed in this planning process that might be instigated. To my knowledge, it does not exist today. Without it, technology use by industry will remain spotty and serendipitous.

To this end, the roles and the makeup of the critical technology planning council and advisory panel that S. 979 refers to takes on a very special perspective. They must be formulated correctly to adequately represent the customer's view. If not, the communications, the credibility, and the shelf-stocking mechanisms will be severely handicapped.

Now, let me go on to a second area of comment. The concept of partnerships among DOE labs and industry and universities is certainly also very important. We have already heard today, and it is a kind of time-worn cliche that there are cultural differences between government, industry, and university research worlds. But the differences are real, and they do impede the constructive, effective, and once again timely collaboration between these individually strong, but collectively somewhat mediocre technical establishments.

Three features of S. 979 take steps which can move toward closer and more successful partnering. One of these is the ability of the players in the proposed partnerships to choose the lead institution, presumably the best one as judged by the partners. That should go a long way to helping to choose the best leadership for any particular partnership. Secondly, people ought to be able to move and should move not only from industry to DOE labs, which is done fairly extensively now, but into industry from the laboratories where the researchers can get a better appreciation of industrial needs and what it takes to make technology commercializable. Thirdly, some of the funds can be available to help seed both the technology development and the collaboration itself. This additional funding could go a long way toward making additional collaboration useful.

These three features can contribute to a clearer understanding of each other's needs and skills, can strengthen trust and cooperation, and will certainly improve the planning, coordination and timeliness of the partnership results.

Let me add a word of caution. Partnering is not an easy process. It works only with hard work, commitment and patience. We might even be prepared to tolerate some failures along the way in the process of establishing partnerships, but also remember successful partnerships can be real dynamos.

I would not want to conclude this oral testimony without saying there are no single solutions. There are no silver bullets in the establishment and maintenance of competitive business leadership. There are many necessary elements that, when put together and fitted into a complete picture, form the economic success we all want. The technology issues of S. 979 are but one of many needs, and they include sound fiscal environment, available capital, affordable capital, increased protection of intellectual property rights, product liability reform, and a host of other things that I am sure you are all aware of. UTC and NAM continue to strongly support these needs also.

So, in conclusion, let me just say that the DOE labs certainly represent a large U.S. investment. They have skills and equipment which can make a significant contribution to the development of critical technologies in support of both economic prosperity and defense security. This contribution can be substantially improved with more long-term planning and collaborative planning within the broad framework of the sense of partnership with the private sector.

It certainly is unreasonable to expect that the DOE labs will be a U.S. economic silver bullet but they certainly can become one sharp arrow in our quiver of arrows as we engage our competition. To this end, S. 979 can contribute to this vision.

Thank you for the opportunity to present these comments. I will be happy to answer any questions you might have.

[The prepared statement of Dr. Owczarski follows:]

Prepared Statement of Dr. William A. Owczarski, Director, External Technology Development, United Technologies Corp., on Behalf of the National Association of Manufacturers

Mr. Chairman and members of the Subcommittee, my name is Bill Owczarski and I am Director, External Technology Development for United Technologies Corporation. I also chair the National Association of Manufacturers' Technology Policy Task Force, and represent them here this afternoon as well. On behalf of both UTC and NAM, I want to thank you for giving me the opportunity to present our views on S. 979, the Department of Energy Critical Technologies of 1991.

To begin, I should like to quote from the "Findings" portion of S. 979: "It is essential that the United States maintain a world leadership position in the development and application of technologies that are critical to national security and economic prosperity." This is a statement we heartily endorse. In that spirit, Mr. Chairman, we compliment you and the Subcommittee for bringing this subject into the light of public debate. Senators Bingaman, Johnston and Domenici also deserve credit for their leadership in crafting S. 979, as it addresses in very constructive ways new approaches to the quest for that world leadership position.

Integral to these approaches are the Department of Energy (DOE) laboratories, which have served our nation so well in their traditional missions. They have, in the process, developed an impressive array of engineering and scientific skills, as well as extraordinary equipment and physical facilities. As a company that is now engaged in collaborative research projects with several DOE labs, we can attest to the value that can be obtained from their capabilities.

As we understand it, the main goals of S. 979 are: (1) to provide additional coordination and focus for the research and development activities of the DOE laboratories, with an emphasis on the recently identified "Critical Technologies"; (2) to institute a DOE long-range planning process and produce plans to support those technologies; and (3) to continue fostering the commercialization of the DOE laboratory critical technologies by means of laboratory, industry and university partnerships that will receive new funding support. These goals are worthy of support and, if achieved, can improve the already growing process of federal technology utilization and commercialization by U.S. industry.

I would like now to focus some specific comments on the planning and partnership facets of this subject, in the hope of stimulating actions in certain directions and encouraging their implementation. In this regard, these comments are based on recommendations proposed in a previously issued NAM paper that I have appended to my written testimony. I ask that it also be made part of the hearing record.

DEVELOPING A LONG-TERM PLAN IS AS CRITICAL TO SUCCESS AS IS THE PLANNING PROCESS TO ACHIEVE IT

The plan and planning process must address a number of issues. Within the plan, the role and missions of the DOE laboratories must be clearly defined. The labs, cumulatively and individually, are such large enterprises that their missions warrant attention to assure that the investment they represent is effectively used. Surely, much of their defense and energy missions will remain. Their technology development role for competitiveness is a new role, however, and one that needs to be understood and articulated both inside the laboratories and in industry—their new customers.

The DOE laboratories face many of the same challenges in their missions as do corporate central laboratories. For example, they perform only a small fraction of the total R&D leading to the commercialization of any product they serve and support. Also, they tend to focus on R&D in areas where they have unique capabilities and where critical mass that can make a difference. The recognition of this in S. 979 under the section on core competencies is correct. No lab should try to do everything; focusing on a few things they can do well is important.

Also as in the case of corporate central labs, the R&D agenda must be established in close consort with the "customer." Communications and credibility form a critical factor in the success of corporate labs, and both of these begin with selecting a relevant R&D agenda. A relevant R&D agenda is not unlike the decisions a grocer makes in stocking his shelves: He must know what his customer needs and stock his shelves accordingly to have a flourishing business.

R&D must be customer driven to be worthwhile and effectively applied. Successful corporate laboratories work diligently with their customers to choose and then execute the right agenda. The DOE labs are able to work closely with their national defense "customers" on weapons programs, and models for planning R&D in that particular arena are successful. The DOE labs will, however, need to take new approaches to develop a success-oriented process for defining R&D where the expectation is for the resulting technology to find its way—cost effectively—into commercial products. Perhaps even more important, the technology must be developed in a timely fashion. Timeliness is a critical factor in a competitive environment.

Simply setting an agenda based on work in a technology field that is acknowledged to be critical is unlikely to be an effective use of resources. Developing a model in which industrial needs drive a DOE lab R&D agenda must be addressed in the planning process. Such a model does not exist today. Without it, technology use by industry will remain spotty and serendipitous, rather than a managed activity with efficient and, again, timely results.

To this end, the roles of the Critical Technologies Planning Council and the Critical Technologies Advisory Board, referred to in Title I of S. 979, take on a very special meaning. If these are not formulated so as to adequately represent "the customer" (i.e., industry), the communications, credibility and "shelf-stocking mechanisms" of the labs will be severely handicapped.

THE CONCEPT OF PARTNERSHIPS AMONG DOE LABORATORIES, INDUSTRY AND UNIVERSITIES IS IMPORTANT

While it may be a time-worn cliché, there are cultural differences among the government, university and industrial research and development worlds. These differences impede the constructive, effective and, once again, timely collaborative flow among our independently strong, but collectively mediocre, technical establishments. Three features of S. 979 offer steps toward closer and more successful partnering: (1) the ability of participants to choose the lead institution, presumably the best as judged by the partners; (2) that people can move not only from industry into DOE labs, but also into industry from DOE laboratories; and (3) that some funds can be made available to help "seed" both the technology development and the collaboration.

These three features can contribute to clearer understanding of each others' needs and skills, can strengthen trust and cooperation, and will certainly improve the planning, coordination and timeliness of the partnerships results. A word of caution, however: Partnering is not an easy process. It works well only with much hard work, commitment and patience. We should even expect and be prepared to tolerate some failures. But, successful partnerships can be dynamos.

Before concluding, I should like to make it clear that there are no silver bullets in the establishment and maintenance of competitive, world-leadership businesses. There are only many necessary and possible elements that, when fitted together, form the picture of success we all want. Technology issues are joined by other needs such as a sound fiscal environment, available, affordable and patient capital, R&D tax incentives, increased protection of intellectual property rights, product liability reform, procurement practice reform and others. UTC and NAM continue to support these needs also.

IN CONCLUSION

The DOE laboratories are a large U.S. investment and have skills and equipment that can make significant contributions to the development of critical technologies in support of both economic security and defense security. This can be done better with more far-term and collaborative planning within the framework of partnerships with the private sector. S. 979 can contribute to this vision.

It is unreasonable to expect that the DOE labs will be a silver bullet, but they can and should be one sharper arrow in our quiver as we engage our competition.

Thank you for the opportunity to present these comments. I will be happy to answer any questions you may have.

NAM

Technology Policy Recommendations

Executive Summary

American manufacturers, both large and small, face markets that are both increasingly global and competitive. A key factor in successfully meeting this competition will be the effective development, deployment and use of technology resources. There has been considerable debate over how to best accomplish this, particularly in defining the proper role of government. To date, however, few concrete actions have been taken.

NAM believes an essential role of government is to facilitate and encourage technological innovation and strategic thinking, and to exercise its inherent powers to mitigate the international competitive market distortions faced by U.S. companies. We also believe that this type of role for government does not compromise our underlying commitment to free-market principles. As a contribution to improving our global competitiveness, the NAM offers the following suggested steps that we believe to be achievable in the current political and economic climate.

First and foremost, NAM believes that a sound fiscal and monetary environment is the single most critical factor both in strengthening U.S. competitiveness overall and in devising effective technology policies in particular. In making the technology policy recommendations contained herein, NAM offers suggestions that are intended to be complementary--*and in no way replace or become alternative*--to ongoing NAM policy thrusts in areas such as deficit reduction, the availability and cost of capital, R&D tax incentives, improvements in education, product liability reform, increased protection of intellectual property rights, international trade, modernization of U.S. antitrust regulations and others. Rather, NAM's recommendations consist of three technology-focused issue areas for action and attention: a more constructive industry-government relationship; more effective use of the federal laboratory system; and consideration of alternative means of support for technology development. These recommendations are:

Industry-Government Relations

- Restore and strengthen the Commerce Department's ability to gather and analyze economic data necessary to provide a better understanding of the factors, particularly the role of technology, that currently drive international competitiveness.
- Encourage efforts to restore trust in industry-government relations.
- Increase participation by industry leaders (both business and technical) in the interagency processes for coordination of technology information.
- Institute a competitiveness information campaign based on the message "Keep America Prosperous."

The Federal Laboratory System

- Involve industry more in the selection and planning of research agendas at federal laboratories by establishing industry research advisory councils.
- Create technology "focus centers" at federal laboratories in those technologies or disciplines that build on the unique strengths and talents of the individual labs and are useful to industry.
- Emphasize process-related manufacturing research in developing agendas for the federal laboratories to help U.S. industry.
- Encourage regional collaboration among the federal laboratories, universities and industry.
- Promote and expand person-to-person contacts and personnel exchanges between industry and government laboratories.
- Strengthen technology "marketing" activities throughout the federal laboratory system to help more businesses, particularly small- and medium-sized ones, become aware of available resources.

Meeting the Future

- Expand and invigorate the current defense R&D effort and infrastructure.
- Provide the Advanced Technology Program with a degree of support sufficient to make possible its success.
- Allow and encourage more productive intra- and inter-industry relationships.
- Keep open and explore options to support even further "downstream" pre-competitive development efforts in enabling technologies if such support is deemed necessary.

Technology Policy Recommendations

Introduction

In setting forth its policy recommendations, the National Association of Manufacturers proceeds from the conviction that manufacturing is the foundation upon which rests this nation's economic strength and national security. Many government policies, however, tend to inhibit the competitiveness of American manufacturers, with deleterious effects on the economy as a whole. While a consensus has been lacking as to what needs to be done to change this situation, NAM believes that there are steps that can be taken now to improve the ability of industry to flourish in the United States.

First and foremost, NAM believes that a sound fiscal and monetary environment is the single most critical factor both in strengthening U.S. competitiveness overall and in devising effective technology policies in particular. We assert that the federal budget deficit--and its attendant ills of high capital costs, shortened time horizons and others--constitute major burdens on the ability of U.S. manufacturers to compete. Failure to solve *this* problem could render all other actions ineffective.

For the most part, however, these recommendations avoid contentious budget and ideological matters. Rather, action on these issues is intended to be complementary--*and in no way replaces or becomes alternative*--to ongoing NAM policy thrusts in areas such as deficit reduction, the availability and cost of capital, R&D tax incentives, improvements in education, product liability reform, increased protection of intellectual property rights, international trade, modernization of U.S. antitrust law and others.

NAM's recommendations consist of three technology-focused issue areas for action and attention: a more constructive industry-government relationship; more effective use of the federal laboratory system; and consideration of alternative means of support for technology development.

These policy prescriptions are not propounded as all-inclusive or original. Rather, they are actions that can be accomplished in the current political and fiscal climate. NAM's proposals spring from technology-related matters we perceive to be important and offer options that we believe can make a difference.

Industry-Government Relations

Several domestic industry sectors have suffered competitiveness setbacks in recent years. Some part of this decline can be attributed to the practice of foreign governments targeting specific industries for development. Whether through trade policy, direct financial aid, technology development or providing leadership in establishing national goals to focus energy and resources on key segments of international industrial competition, these practices have frequently had a deleterious effect on domestic U.S. producers.

In the United States, it is not government's role to direct industrial development or, to use the shopworn phrase, "pick winners and losers." NAM believes it is an essential role of government to facilitate and encourage technological innovation and strategic thinking, and to exercise its inherent powers to mitigate the international competitive market distortions faced by U.S. companies. NAM believes that this type of role for government does not compromise our underlying commitment to free-market principles.

A Critical Need for Quality Data and Analysis

Essential information, such as timely technology assessments, and an increased ability to spot trends useful to overall strategic planning are critical if U.S. industry is to understand and successfully meet international competitive realities. To create this capability, government must work cooperatively with industry to define and determine the type of essential data needed, to facilitate its collection in a non-burdensome and non-duplicative fashion, to provide competent analysis, and be receptive to the results--whether favorable or unfavorable--such an effort would yield.

Out of this process, ideally, industry and government will be able to assess when losses in key industries are harmful to U.S. economic security and be prepared to lead public discussion to mobilize appropriate and effective policy responses.

The Catalytic Role of Government

Given our historical antitrust concerns and the disaggregation of U.S. industry among large and small businesses, such a dialogue would be difficult to realize if left entirely to industry's initiative. Nor can such a role be played only by state or local government bodies.

Only the federal government has the necessary convening powers to invite the various parties to the table and to provide the depth and breadth of information the challenges of greater cooperation and dialogue between government, industry, academia and labor require.

Such dialogue will foster a better understanding of the actions that must be taken to keep American manufacturing competitive. Combined with improved data collection and analysis, constructive government-industry cooperation will flow from the very process of this dialogue. When critical decisions or strategy judgements are needed, an open and trusting atmosphere will allow selection of appropriate and effective public/private advisory organizations that can bring forth better ideas and solid courses of action.

Government as Competitiveness Champion

The government must include in its unique communication role an effort to inform and persuade the public of the importance of a sound economy, and the factors--including that of a technologically driven, vibrant manufacturing sector--that go into one. Industry should stress the importance of quality manufacturing to a strong national economy as well as the need for manufacturers to seek international markets for their products. All other American goals, whether measured in terms of national security or standard of living, rest on our ability to perform economically. Economic well-being is not secondary to military well-being; rather, both are indispensable components of national security.

Recommendations

1. Restore and strengthen the Commerce Department's ability to gather and analyze economic data necessary to provide a better understanding of the factors, particularly the role of technology, that currently drive international competitiveness. One key area in urgent need of reform is the increasingly outdated system of Standard Industrial Classification (SIC) Codes. Also, recently legislated efforts to identify "critical" technologies (both commercial and military) and produce comparative assessments of technological developments and trends through the Departments of Defense and Commerce and the White House Office of Science and Technology Policy should be supported and encouraged. Closer industry-government cooperation is essential to make these efforts successful and worthwhile.

2. Encourage efforts to restore trust in industry-government relations. The federal government, whether through the Commerce Department, Office of Science and Technology Policy or other bodies, should continue and expand government's dialogue with industry and among industries to promote greater trust and confidence between the public and private sectors. One important outcome of this effort would be a sharing of strategic views relating to international business, economics, national security, and domestic well-being.

3. Increase participation by industry leaders (both business and technical) in the interagency processes for coordination of technology information. The revitalization of the Federal Coordinating Committee for Science, Engineering and Technology (FCCSET), the recent formation of the President's Council of Advisers on Science and Technology (PCAST) and the National Academy of Sciences/National Academy of Engineering's Manufacturing Forum, and the anticipated formation of an Industry Technology Advisory Board by the Commerce Department should be commended and supported in every possible manner by industry.

4. Institute a competitiveness information campaign. Starting with the president, a message to "Keep America Prosperous" should be articulated to the populace. The Department of Commerce needs an economic equivalent of "Smokey the Bear" to remind us of the importance of economic well-being, why global trade is vital to American industry and how manufacturing and technology supports the U.S. competitive position. For its part, the National Association of Manufacturers is actively exploring the feasibility of a multiyear manufacturing awareness campaign to return industry to the position of respect it once had among policy makers and the general public in this country.

The Federal Laboratory System and Technology Transfer

NAM regards the federal laboratory system in this country as a national asset. In light of far-reaching changes in the nature of national security and international competition, however, the mission and role of the entire federal laboratory system should be reexamined in terms of its usefulness. For example, should more of the labs' $20 billion R&D budget be directed to efforts more relevant to industry's needs? In short, what is needed now is specific input on how to improve the effectiveness of technology transfer.

Much attention has been paid to the idea of improving the flow of technology and innovation from the national laboratories to the commercial economy. In the past decade, in particular, legislation and executive orders have stripped away the legal and bureaucratic barriers to domestic technology transfer. Still, we are left with ingrained attitudes and mindsets that must be changed in order to gain the most benefit from our national laboratories.

Improved Lab-Industry Interaction

The federal laboratories' value lies mainly in two areas: human resources and equipment. Greater interaction with the former and increased access to and usage of the latter should be a goal of the manufacturing community. The relative lack of effective communication (or, sometimes, even an *interest* in communication) between federal laboratories and industry is a barrier to effective technology transfer activities. Both sides of this proposed dialogue need to communicate.

Industry must do a better job in searching out technology wherever it exists, whether in American or foreign factories and laboratories. Government must make a better effort at facilitating awareness and transfer of technologies to U.S. industry, particularly to small- and medium-size companies.

Manufacturing: Process vs. Product

Countries with the most sophisticated manufacturing processes will have an edge over those that invest their talents primarily in the products themselves. The United States has been hurt by the fact that it spends less than Japan or Europe on process R&D. According to MIT's Lester Thurow, "By 1993, if you're not the low-cost producer of a product and can't see yourself becoming the low-cost producer of a product, forget about inventing it. I can buy my neighbor's product and reverse engineer it, but I can't buy his process—the way to make it for less."

Finding and using "the way to make it for less" is achievable only if U.S. industry and government communicate and cooperate more.

Industry must implement innovative, low-cost manufacturing processes and systems that integrate, improve and shorten the production cycle (concurrent engineering). Just as importantly, the federal government should recognize the criticality of manufacturing processes in prioritizing and formulating its R&D budgets.

Recommendations

1. Involve industry directly in the selection and planning of research agendas at federal laboratories by establishing industry research advisory councils. Such advisory panels will ensure closer interaction and collaboration between industry and the laboratories from the earliest stages.

2. Create technology "focus centers" at federal laboratories in those technologies or disciplines that build on the unique strengths and talents of the individual labs and are useful to industry. Focus centers would complement efforts such as the National Science Foundation's Engineering Research Centers and Science and Technology Centers, numerous state-level "centers of excellence" and other programs already underway. The funding of any new industrial research efforts should be coordinated closely with the above existing research activities, as well as with the Small Business Innovate Research (SBIR) program, the Defense Department's Industrial Modernization Incentives Program (IMIP) and Manufacturing Technology (ManTech) programs, the Commerce Department's Advanced Technology Program and others.

3. Emphasize manufacturing and process-related research in developing agendas for the federal laboratories to help U.S. industry. Government policy makers should become more aware of the critical importance of manufacturing process and the need to nourish vigorous R&D in this area in allocating limited federal resources. In close coordination with industry, a larger role for the national laboratories in exploring solutions to these generic manufacturing problems should be encouraged.

4. Encourage regional federal laboratory/state agency/university/industry collaboration. These symbiotic relationships would foster increased attention to engineering and technical fields by students, provide universities with additional incentives they can use to attract students, and help industry by nurturing production of the next generation of talent for industry to draw upon. For traditionally less "glamorous" fields such as manufacturing, attracting greater student interest would be most beneficial.

5. Encourage and expand person-to-person contacts and personnel exchanges. Direct exchanges of this type are the surest means to accomplish technology transfer. Programs that bring industry researchers into the federal laboratory structure should be continued and efforts to facilitate greater participation by small and medium-sized businesses pursued. One means of accomplishing this would be to amend the R&D tax credit to allow a company's expenses involved in these exchange programs to qualify for the credit. A complementary program of encouraging government researchers to work temporarily in industry labs should also be implemented. This would not only provide individual manufacturers with a valuable resource but also introduce into the federal lab system a greater understanding and awareness of industry's needs (upon the federal researcher's return to the laboratory).

6. Strengthen the technology "marketing" role throughout the federal laboratory system to help more businesses, particularly small- and medium- sized ones, become aware of available resources. Assigning federal technology transfer entities a specific outreach, or marketing, function would require significant, but not impossible, changes in organizational structure (to rationalize the diffusion process), personnel management practices (to provide adequate incentives and rewards for success) and budgeting (to make effective marketing a realistic goal). A strengthened and expanded Federal Laboratory Consortium should be part of this effort.

Meeting the Future

The global strategic posture of the United States is shifting away from one viewed in principally military terms. The recent "end" of the Cold War has brought this shift into sharp focus, with economic power clearly moving to center stage. One key determinant of economic power will be the development and application of technology. The foundation of technological strength, in turn, lies in a vigorous R&D effort by both industry and government.

While there is disagreement in terms of scope and scale, few argue against a continuation of government's long-standing involvement in defense-related technology development. NAM believes that, whether or not the current diminution of strategic military threats is a long-term trend, the need to maintain technological capabilities to respond to potential threats remains. In fact, given that the U.S. military structure is likely to decrease quantitatively, the need for technological superiority becomes even more vital.

In the commercial arena, the private sector must retain its leading, though not necessarily exclusive, role in technology development. The ability to do this, however, requires a supportive government--one that at a minimum nurtures an environment conducive to innovation. Industry should carefully examine and evaluate its framework of arrangements within and among individual U.S. industry sectors as a means to achieve more productive and competitive relationships.

Adapting to Change

Competition among nations has always taken many forms, and only those socio-political-economic systems capable of adapting to the changing competitive environment can expect to continue. To meet the unprecedented challenges posed by the Second World War, for example, government-industry relations in the United States experienced significant changes. From a pre-war near-indifference of the federal government to science and research, it became accepted that there was indeed a legitimate and positive federal role in stimulating scientific education and advancement. The result has been nearly a half-century of strong government support for science research and experimentation, and a concomitant position of global scientific leadership.

Because of the increased emphasis on global "techno-economic" competition, the perceived "traditional" theoretical framework of industry-government relationships in the United States may now again be in need of adjustment. This does not mean that existing paradigms should be discarded in favor of government-led industrial policies or "technology-of-the-week" approaches. Rather, in light of anticipated international economic and competitive realities, alternate, industry-led means of promoting U.S. technological leadership in both defense and nondefense areas should be considered.

The Advanced Technology Program (ATP) created by the 1988 Omnibus Trade and Competitiveness Act, whose purpose is to assist U.S. businesses to carry out R&D on pre-competitive, enabling technologies, is one such vehicle.

Recommendations

1. Expand and invigorate the current defense R&D effort and infrastructure. The ability to respond rapidly to future defense challenges is a vital ingredient in maintaining U.S. national security. NAM believes that bolstering the existing defense research base is not at cross purposes with changes in the focus of the defense R&D effort, as suggested by the recommendations above.

2. Allow and encourage more productive intra- and inter-industry relationships. One prototype for this can be found in the Aerospace Industries Association of America's (AIA) Aerospace Technology Policy Forum and its "Key Technologies for the 1990s" program. These industry-led activities bring together government, academia and industry to define and support nationwide technology development efforts aimed at keeping this particular industry globally competitive. As a broad-based manufacturing association, NAM should take the lead in encouraging its members in all industry sectors to undertake similar, critical self-examinations.

3. Provide the Advanced Technology Program with a level of support sufficient to make possible its success. The ATP is a useful and important experiment that requires a clear sense of mission and purpose, a specified duration, adequate funding, an objective measurement of successfulness and a willingness to recognize the experiment's outcome in its totality--whatever the results may be--by industry and government alike.

4. Keep open and explore options to support even further "downstream" pre-competitive development efforts in enabling technologies if, through the analysis and processes proposed above, such support is deemed necessary. Clearly, programs of this type will achieve success only if: (1) the convening activity re-establishes trust, openness and confidence between government and industry; (2) the information and analytical resources are present to establish needs and opportunities; and (3) public opinion, government and industry all believe it is important and correct to do so.

-- NAM, 1990 --

These recommendations were developed by NAM's Technology Policy Task Force, under the auspices of the NAM Council on High Technology. Questions or comments regarding these recommendations should be directed to Council staff director William G. Morin at (202) 637-3147.

Senator SHELBY. Thank you.
Dr. Wilks.

STATEMENT OF DR. ALAN D. WILKS, VICE PRESIDENT, RESEARCH AND TECHNOLOGY, ALLIED-SIGNAL, INC., ON BEHALF OF UNITED STATES ADVANCED CERAMICS ASSOCIATION AND ALLIED-SIGNAL AEROSPACE, DES PLAINES, IL

Dr. WILKS. Mr. Chairman, members of the committee, I am Alan D. Wilks, Vice President of Research and Technology for Allied-Signal. I am here today in a dual capacity, representing the United States Advanced Ceramics Association and Allied-Signal Aerospace, which is one of the founding members of USACA. I thank you, Mr. Chairman, and the committee for the opportunity to speak here today in support of both the spirit of Senate bill 979 and on behalf of the national laboratories.

On behalf of USACA, I commend Senator Bingaman and the Senate Energy Committee for their recognition of the need to set forth a policy for development of U.S. critical technologies.

USACA is working to develop a strong and viable domestic advanced ceramics and materials industry which we believe is essential to the future of the Nation's employment, national security, gross national product, balance of trade, all those things that we like to think are good. Our foreign competitors have targeted advanced ceramics as a key to industrial competitiveness and are aggressively developing that technology.

The United States is beginning to recognize the need to take on this challenge. Advanced ceramics and materials have been identified as technologies critical to the Nation's economic prosperity and security in every major private and public sector key technology listing compiled over the past several years, including the National Critical Technologies Panel report. But while materials are making the lists, USACA believes that the Federal Government needs to work with industry on a comprehensive initiative to ensure a clear U.S. leadership in the commercial materials market.

From its inception, USACA has encouraged the development of Federal programs to help industry take advanced materials technology from the research stage to the marketplace. To assist policymakers in this process, USACA has developed a six-point advanced development and commercialization program, better known as the Bridging the Gap initiative. It is to provide some guidance for what we think are important issues in doing this important job.

In S. 979, we see the beginning of a new approach to improving America's competitiveness in the changing world marketplace. The legislation recognizes the need for industry and government to walk side by side as we enter the next generation of global competition, a competition that we see being led largely by the materials industry, not uniquely, but largely. While USACA views S. 979 as a good start, we would like to address some of the provisions of the bill that we feel deserve additional consideration.

First, we believe the bill must place more emphasis on programs to develop advanced materials beyond the basic research stage. During the post-research, pre-commercialization stage of product development, government can best assist advanced materials companies with programs for evaluation, demonstration, and insertion, and purchase incentives.

Second, realistic cost-sharing requirements must be incorporated into this type of legislation. Non-Federal Government contribution requirements must be placed on a sliding scale which truly reflects the proprietary benefit received by the participants. Companies are not quick to enter into and fund partnerships which yield equal benefits to their non-paying competitors.

Finally, in regard to partnership provisions of the bill, USACA generally supports the creation of programs which foster partnerships and teams. To address the competitiveness challenge facing our Nation, however, these types of partnership programs must be driven by U.S. industrial needs with the ultimate objective of being the commercialization of products in the marketplace. USACA believes the industry must be intimately involved in the leadership of each of the partnerships for the programs to be effective.

The Department of Energy continuous fiber ceramic composite initiative is a prime example of how government and industry can effectively work together in a multi-year R&D partnership. One of the reasons that it is so successful is it places overall managerial and oversight responsibility in the hands of DOE while industry takes the leadership role in the development, implementation, direct management of the individual research and development programs. Once a project is funded, a lead corporation serves as the prime contractor. Clearly industry will maintain a commercial focus as the lead institution in the partnership. The competitiveness of the marketplace demands that it happen that way.

Federal laboratories play a key role in this continuous fiber ceramic composite program. The laboratories' involvement in assisting DOE with overall program management and coordination, as well as their technical expertise to support the specific project needs is essential for program success. USACA recommends that the laboratories play a similar role supporting any new materials initiative.

Now I would like to address the role of the national laboratories in America's struggle to remain on top as the world enters a new era of global economic competition.

Let us go back in history for a moment. The initial charter of the national laboratories was to provide for the national defense. That definition was further refined to address the most significant threat the country faced, which at the time was the post-World War II Soviet Union. Recent history you can read as confirming that the laboratories in the Nation met that challenge well.

The character of the world has changed, however, over the last decade. We now find ourselves facing new challenges. The United States is now in the uncomfortable position of becoming a second class power in some technological fields which we created. We are grappling with this reality and attempting to better understand the options and opportunities available to us today.

And there is no technology organization with more untapped potential than the national laboratory system. The skills and facilities resident in our labs can be partially redirected toward a new threat to the national well-being, the growth of offshore economic powers which displace U.S. manufactured goods from the marketplace and put U.S. workers out of jobs. The laboratory network has the facilities and brain power to regain the leadership role and essentially any technology which the Nation decides is important.

What stands in our way? Because the laboratories have in some respects achieved their original goals, they are now at a turning point. They face an uncertain future. Congress and the administration need to convince the laboratory staffs that the country will continue to reward the dedication of their careers to the national good. If these scientists are not secure, those who have options—and this is key. Quite often the minds most critical to meeting the challenges we face now are the people who have those options—will leave. Those are people who can, to some extent, work where they want to work. Unless these scientific leaders believe in our commitment to ensuring U.S. competitiveness in high tech areas and understand our desire and appreciation for their leadership, they will not act with the dedication and energy that has marked the historical activities of these lands.

I think Congress needs to address a few things here. We need to address the improvement in integrating technology into the private sector. That is what this bill is aimed at doing. That is appropriate. The government restrictions placed on business in its interaction with the national laboratories needs to be streamlined to some extent. The creation of clear incentives for industry to take the risk—and it is a risk—to develop a close working relationship with the labs has to occur. The labs' billable manpower costs, which quite often exceed industry's, discourages investment by industry in support of laboratory staff. Finally, the complex intellectual property issues which exist are often a severe roadblock, stopping interaction before it ever gets going.

To summarize, we must continue to honor the commitment we have made to the labs, recognizing the careers the staff have devoted to the Nation. We must get the message across to these scientists that their mission is important and vital and that we will stay the course with them as we enter a new age in the evolution of the national laboratory system. We must provide incentives for industry to seek out and utilize these resources to improve its technology base and competitive posture. The failure to achieve our goals through a healthy laboratory system still would not strip us of all of our options. On the other hand, allowing this tremendous resource to degrade into a non-competitive posture would be inexcusable and not quickly corrected. The Federal Government must act to preserve technology competitiveness options for the present and future by broadening the charter of the laboratories to include the critical technologies recently recognized by the National Critical Technologies Panel, Council on Competitiveness, the Department of Commerce, and the Department of Defense.

The spirit of S. 979 is certainly a step in the right direction, but it must be viewed as only one of the many steps we must take together.

That ends my testimony.

[The prepared statement of Dr. Wilks follows:]

PREPARED STATEMENT OF DR. ALAN D. WILKS, VICE PRESIDENT, RESEARCH AND TECHNOLOGY, ALLIED-SIGNAL, INC., ON BEHALF OF UNITED STATES ADVANCED CERAMICS ASSOCIATION AND ALLIED-SIGNAL AEROSPACE, DES PLAINES, IL

INTRODUCTION

Mr. Chairman and members of the committee, I am Alan D. Wilks, Vice President of Research and Technology for Allied-Signal Inc. I'm here today in a dual capacity representing the United States Advanced Ceramics Association (USACA) and Allied-Signal Aerospace, one of the founding members of USACA. I thank you Mr. Chairman, and the committee, for the opportunity to speak in support of both the spirit of S. 979 and our national laboratories.

On behalf of the United States Advanced Ceramics Association I commend Senator Bingaman and the Senate Energy Committee for their recognition of the need to set forth a policy for development of U.S. critical technologies. USACA represents more than 30 U.S. manufacturers and users of advanced structural and electronic ceramic products. The association promotes the commercialization of advanced ceramic products through USACA's advocacy programs, which are designed to help Congress, the executive branch and the public better understand industry needs.

USACA is working for the development of a strong and viable domestic advanced ceramics and materials industry, which is essential to the future of the nation's employment, security, gross national product and balance of trade. Our foreign competitors have targeted advanced ceramics as a key to industrial competitiveness and are aggressively developing the technology.

The United States has recognized the need to take on this challenge. Advanced ceramics and materials have been identified as technologies critical to the nation's economic prosperity and security in every major private and public sector key technology listing composed in the past several years, including the National Critical Technologies Panel Report. But, while materials are making the lists, USACA believes the federal government needs to work with industry on a more comprehensive initiative to ensure clear U.S. leadership in the commercial materials market.

From its inception, USACA has encouraged the development of federal programs to help industry take advanced materials technology from the research stage to the marketplace. To assist policymakers in this process, USACA developed a six-point "Advanced Development and Commercialization Program," better known as the "Bridging the Gap" initiative. It provides policymakers with a guide to programs to help ensure a strong U.S. materials industry into the next century. The initiative provides a blueprint of the types of advanced materials R&D, product evaluation and demonstration, product insertion, and public and private sector purchase incentive programs that USACA supports. I ask the committee's permission to have the "Bridging the Gap" initiative entered into the record.

S. 979

In S. 979 we see the beginning of a new approach to improving America's competitiveness in the changing world marketplace. The legislation recognizes the need for industry and government to walk side by side as we enter the next generation of global competition, a competition that we see as being led largely by the materials industry. While USACA views S. 979 as a good start, we would like to address some of the provisions of the bill that the association feels may need some additional consideration.

In regard to the partnership provisions of the bill, USACA generally supports the creation of programs which foster partnerships and teams. The association regards the Department of Energy Continuous Fiber Ceramic Composite initiative as a prime example of how government and industry can effectively work together in a multi-year R&D partnership.

USACA believes that industry must be intimately involved in the leadership of each of the partnerships for the programs to be effective. One of the reasons the CFCC program is successful is that it places overall managerial and oversight responsibility in the hands of the DoE, while industry takes the leadership role in the development, implementation and direct management of the individual research and development projects. Once a project is funded, a lead corporation serves as a prime contractor.

Federal laboratories also play a key role in the CFCC program. The laboratories' involvement in assisting DoE with overall program management and coordination, as well as their technical expertise to support the specific project needs, is essential to the program's success. USACA recommends that the laboratories play a similar supporting role in any new materials programs. In a moment, I will take the opportunity to address the role of the national laboratories in more detail.

An advanced materials industry/government partnership program would provide a vehicle to organize the kind of group needed to conduct pre-competitive materials research. Such a partnership would help the advanced ceramics industry leapfrog ahead with new and innovative materials technology and products. USACA envisions partnerships that would strive to identify materials able to work at temperatures in excess of 3,500 degrees, which will form the basis for consumer and industrial products commonly used during the next century.

New advanced materials partnership legislation must focus on programs driven by U.S. industrial needs. For industry/government partnerships to work effectively, the ultimate objective must be the commercialization of products in the marketplace. Clearly industry will maintain a commercial focus as the lead institution in the partnership. The competitiveness of the market will demand it.

To this end, we believe S. 979 must place more emphasis on programs to develop advanced materials beyond the basic research stage. During the post-research/pre-commercialization stage of product development, government may best assist advanced materials companies with programs for evaluation, demonstration and insertion, and purchase incentives.

For example, a fleet evaluation program that focused on demonstrating the capabilities and qualities of ceramic engines and engine components would assist not only the manufacturers of those parts, but also the end users, such as General Motors, Ford Motor Company and Chrysler Motor Corporation. Procurement policies set by the Department of Defense (DoD) and the General Services Administration (GSA) would give incentives or preference to new products and systems incorporating advanced ceramics. In this kind of program, GSA could purchase cars and trucks with certain amounts of ceramic content such as valves and cam roller followers. DoD could purchase systems after being demonstrated to System Project Offices by the current Defense Advanced Research Projects Agency (DARPA) insertion program. The creation of more programs like the DARPA ceramic insertion program in other departments and agencies is also encouraged.

The federal government plays a vital part in the future competitiveness of America's advanced materials industry. Although our government has begun to prime the pump on this risky, long-term investment, our foreign competitors have already targeted this industry and their governments are aggressively funding new programs. Government and industry both need to do more if our country is to be the seller, and not the buyer, of products created by these enabling technologies.

Congress must increase the overall funding of advanced materials development and commercialization programs. These additional appropriations should be used to fund the creation of new programs and to beef up programs which currently assist industry on the road to commercialization.

Realistic cost-sharing requirements must be incorporated into the partnership programs. Cost-sharing of 25-50 percent may be reasonable, if indirect factors such as capital and technology transfer are included.

Non-federal government contribution requirements must be placed on a sliding scale which truly reflects the proprietary benefit received by the participants, as compared to benefits received by non-participants. Real 50 percent cost-sharing is unreasonable for emerging technologies until they reach the stage of full-scale demonstration. Companies are not quick to enter into and fund partnerships which yield equal benefits to their non-paying competitors.

NATIONAL LABORATORIES

One of the issues this legislation begins to address is the role of the national laboratories in America's struggle to remain on top as the world enters a new era of global economic competition. This nation is most fortunate to have available to it a diverse advanced technology organization of world-class capabilities. The national laboratories were founded approximately 50 years ago in response to a pressing need for the defense of the national interests. The nation was involved in a world war, and the potential was recognized for the conventional rules of warfare to be replaced by a new order. It was imperative that such a change be brought about at the control and direction of the United States. We are all familiar with the history of the Manhattan Project, the site in New Mexico at Los Alamos and the role the atomic bomb played in the conclusion of that conflict and the almost half-century that has followed. What I wish to do here is place that history in the context of today's world and the present and future role of the United States.

In a broad sense the initial charter of the national laboratories was to provide for the national defense. That definition was further refined to address the most significant threat this country faced, which at the time was the post-World-War-II Soviet Union. Recent history has confirmed that the laboratories and the nation met this challenge. The character of the world has changed significantly since this task was begun.

At the end of the Second World War and for some 40 years thereafter the United States was the dominant economic and technological power in the world. There was essentially nothing that was beyond the reach of this nation. Times have changed over the last decade and we find ourselves in the uncomfortable position of becoming a second-class power in some technological fields which we created. We no longer are the nation with the broad shoulders whose sheer industrial might can overcome all obstacles. We are grappling with this reality and attempting to better understand our options and opportunities.

I believe that we are blessed with an opportunity to seize control of our future. There is no technology organization with more untapped potential than the national laboratory system. It devotes much of its energy to development, a difficult scientific and engineering problem. The skills and facilities resident there can be partially redirected toward a new threat to the national well-being, the growth of offshore economic powers which displace U.S. manufactured goods from the marketplace and put Americans out of work. The Laboratory network has the facilities and brainpower to regain the leadership role in any technology which the nation decides is important. What stands in our way?

The laboratories are at a turning point, having in some respects achieved their mission, and face an uncertain future as the squeeze on the budget makes cuts seem attractive and international military power shifts seem to make such actions possible. But, it is critical that Congress recognize the fragility of a high quality laboratory. The federal government must act to preserve technology competitiveness options for the present and future by broadening the charter of the laboratories to include the critical technologies recently recognized by the National Critical Technologies Panel, Council on Competitiveness, the Department of Commerce and the Department of Defense. Surely the laboratories that unlocked the secret of the atom can play an essential role in some or perhaps even all of these critical technology areas.

Furthermore, these facilities house hardware and talent which no industry or group of companies can afford on its own. No one should doubt that we could achieve leadership in the field of, for example, advanced ceramic components, if one or more of these research institutions had that clear responsibility.

In addition to the budgetary issues, there are other obstacles preventing us from using our national labs to enhance our technological competitiveness. First, our track record of integrating such technology into the private sector is not exemplary. There is the problem of convincing the Laboratory staff that the country will continue to reward the dedication of their careers to the national good. If these scientists are not secure, those who have options—quite often the minds most critical to meeting challenges such as we now face—will leave. Such people are in short supply and are difficult to replace; it has taken 40 years to build the in group that presently staffs the national laboratories. Unless these scientific leaders believe in our desire to have them lead us into a position of enhanced technological competitiveness, they will not act with the dedication and energy which has marked the historical activities of the labs. We must believe in the mission we give the labs and be steadfast in our financial and moral encouragement. Anything less may doom the nation to a secondary status in the technological marketplace.

Further, the government must ease the restrictions it places on business in its interaction with the national laboratories. There must be a clear incentive for industry to take the risk of developing a close working relationship with these technology resources. For no apparent reason, the lab's billable manpower costs exceed industry's. This discourages business investment in lab staff support. Complex intellectual property issues are another roadblock which stops interaction before it ever gets going. Anyone who doubts this has only to review the difficulties a company faces in attempting to do proprietary work at a DOE user facility.

There are some success stories. The High Temperature Materials Laboratory at Oak Ridge National Laboratory is one. This is a DOE designated user facility, sponsored by the Office of Transportation Technologies, Conservation and Renewable Energy. Specialized research instruments are grouped in six user centers: Materials Analysis, X-Ray Diffraction, Physical Properties, Mechanical Properties, Ceramic Specimen Preparation, and Residual Stress. Hands-on operation of this equipment by qualified users is encouraged.

A User Center staff is available with special responsibility for interacting with users and maintaining the User Center equipment. Members of the industrial and university research communities gain access to this extensive array of special research equipment needed to characterize the microstructure and microchemistry of materials and to investigate the effect of these parameters on the physical and mechanical properties of the materials through the HTML User Program. The HTML User Program was established in 1987.

Prospective users submit research proposals of the project they wish to undertake in the HTML. The proposals are reviewed by a six-member committee (two from industry, one from university, one DOE, one ORNL, and the HTML director), which meets in the HTML on a quarterly basis. In addition to an approved research proposal, the institution which the prospective user represents executes a User Agreement with Martin Marietta Energy Systems, Inc. To date, 134 agreements have been signed (63 with universities and 71 with industrial companies). More than 200 individuals have performed research in the HTML under these agreements. Approximately 250 publications and presentations have resulted from research performed in the HTML User Program to date.

A DoE partnership program called the Materials-By-Design initiative should also be used as a model when developing future programs. Materials-By-Design is a method of research combining experimentation, computation and theory to allow scientists to use computers to develop and experiment with new materials. The research uses a data base of existing knowledge on the atomic structure of matter. With this information, scientists can create high-tech computer models through which the structure materials can be altered and tailored for specific applications. This approach saves industry time and money as it significantly cuts the time and money required to develop an idea into a marketable product.

Major industrial laboratories use this approach integrating some of the tools of the national laboratories. Such activities are clearly in the interests of the private sector, the national laboratories and the nation. These limited initiatives should be expanded and facilitated by making the advanced capabilities in theory, computation and experimentation more user friendly and available. Now, only large corporations can afford to use a Materials-By-Design approach. The nation, however, is fortunate to have the national laboratories as a resource which enables smaller companies to take advantage of the benefits of this approach. I believe that all top-flight, technology-driven companies will be using the Materials-By-Design approach in the coming decade.

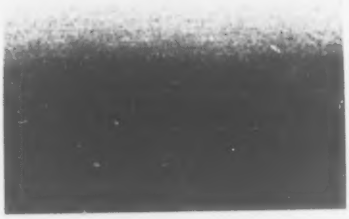
To summarize, we must continue to honor the commitment we have made to the labs, recognizing the careers the staff have devoted to this nation. We must get the message across to these scientists that their mission is important, and that we will stay the course with them as we enter on a new age in the evolution of the national laboratory system. We must provide incentives for industry to seek out and utilize these resources to improve its technology base and competitive posture.

We have to make it work. The stakes are huge and we cannot guarantee success. But it will be very simple to insure failure. The failure to achieve our goals through a healthy laboratory system still would not strip us of all our options. On the other hand, allowing this tremendous resource to degrade into a noncompetitive posture would be inexcusable, and not quickly corrected. The spirit of Senate Bill 979 is certainly a step in the right direction, but it must be viewed as only one of the many steps we must take together.

BRIDGING THE

AN ADVANCED CERAMICS DEVELOPMENT AND COMMERCIALIZATION PROGRAM

OCTOBER 1990



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Caterpillar, Inc.
Champion Spark Plug Company
Chrysler Corporation
Coors Ceramics Company
Corhart Refractories Corporation
Corning Incorporated
Deere & Company
Dow Chemical Company
Dow Corning Corporation
E.I. du Pont de Nemours & Company
Electro Science Laboratories, Inc.
Ethyl Corporation
Ferro Corporation
Ford Motor Company
Allison Gas Turbine Division
General Motors Corporation
W.R. Grace & Company-Conn.
GTE Products Corporation
Hercules Incorporated
IBM
Keramont Corporation
Lanxide Corporation
Martin Marietta Corporation
National Beryllia Inc.
Norton Company
Refractory Composites Inc.
Sullivan Mining Corporation
Sundstrand Power Systems Division
Sundstrand Corporation
Synterials
Textron Specialty Materials
Subsidiary of Textron Inc.
3M Company
Union Carbide Corporation

October 1990

Dear Friends of the Advanced Ceramics Industry:

The 1990s are ushering in a new "Age of Materials." Improved electronic components, new advanced heat engine technologies, the national aerospace plane and other aerospace advances, environmental applications and many additional new technological advances will be possible due to the "enabling technologies" of advanced ceramics and other advanced materials.

The technological marvels that advanced ceramics provide will enhance not only our international competitiveness but also the development of a new and exciting industry that will help the U.S. economy grow while providing jobs for Americans.

The United States Advanced Ceramics Association believes that the development of a strong and viable domestic advanced ceramics and materials industry is essential to the future of the nation's employment, gross national product and balance of trade, and military security. Our foreign competitors, especially Japan, West Germany and France, have all targeted advanced ceramics as a key to industrial competitiveness and are aggressively developing the technology.

In response to this international challenge, USACA has developed a six-point "Advanced Ceramics Development and Commercialization Program," better known as the "Bridging the Gap Initiative."

The Bridging the Gap Initiative is vital to the commercialization and competitiveness of America's advanced ceramics industry. If there is not a greater effort in developing, manufacturing and marketing advanced ceramics and materials, the United States may not be globally competitive.The federal government is uniquely positioned to search out and identify emerging technologies, prime the pump on risky, long-term activities and initiate research and development programs with a clear focus on the ultimate commercialization of those products by private industry.

Above all, there is an urgency to act. Government action cannot be delayed nor programs funded below the critical size necessary for success. The United States has an opportunity to identify and support programs that can help ensure the continued viability of our domestic advanced ceramics industry. If we as a country fail to support this new emerging industry, others in the global economy will accept the challenge, develop the technology and make the products that will leave our country the buyer and not the seller of products created by these new enabling technologies.

The purpose of this document is to provide key policy makers with specific recommendations to help "bridge the gap" between the need for research and development and the ultimate commercialization of advanced ceramic components and parts by the U.S. advanced ceramics industry.

During the 1990s, USACA will be working to implement the programs identified in this document and to identify additional programs and activities for the consideration of public policy decision makers. USACA urges all concerned parties to work with us as we strive to bring the United States into the "Age of Materials."

Sincerely,

Bernard F. Meyer
Chairman of the Board

Marc Newkirk
President

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INTRODUCTION

The United States Advanced Ceramics Association, representing 37 major U.S. manufacturers, users and producers of advanced structural and electronic ceramic products, was formed in 1985 to promote the commercialization of United States structural and electronic ceramic products. It is the leading voice for the U.S. advanced ceramics industry and a key representative of advanced ceramic users and producers before Congress, federal agencies and the public. USACA's role on behalf of the industry is communication, education and advocacy.

Advanced ceramics will be an important part of the advanced materials equation. Advanced ceramics are a keystone technology that will enable us to transcend current technological limits. These materials will affect the competitiveness of the United States in a variety of areas, including the aerospace, automotive, bioceramics, chemical process, defense, electric power generation, electronics, environmental, metals processing and oil industries.

According to the Office of Technology Assessment report "Advanced Materials by Design," "[n]ew structural materials technologies will be a determining factor in the global competitiveness of U.S. manufacturing industries in the 1990s and beyond . . . . Ultimately, both national security and a competitive manufacturing base will depend on a strong domestic advanced materials capability .... When the overall value of these products is taken into account, use of advanced structural materials is likely to have a dramatic impact on gross national product, balance of trade and employment."

The U.S. advanced ceramics industry is moving towards the goal of commercializing advanced ceramics. The industry is increasing its own funding for advanced ceramics research and development and providing jobs for Americans. A USACA-sponsored survey of member companies in 1988 showed that annual domestic industry funding for research and development had increased to over $176 million in 1987, an increase of 58 percent over the previous year. A concurrent USACA survey indicated that member companies employed more than 5,700 people in 1988 and expect that number to increase to more than 39,000 by 2000.

WHAT ARE ADVANCED CERAMICS?

Advanced ceramics represent an enabling technology that is having a revolutionary impact on our nation's industries. These materials will provide the basis for the development of innovative new technologies that will make up a new generation of high-efficiency, high-performance products.

Advanced ceramics include a wide range of inorganic, nonmetallic materials produced by new technologies. They differ from conventional ceramic consumer goods, such as dinnerware, tile and plumbing fixtures, in their greatly improved properties, in the novelty of the processes used to produce them and in their applications.

Monolithic ceramics are produced by compacting and sintering extremely pure, microscopically small particles, which yields properties not achievable with previous techniques, including wear resistance, high temperature strength, chemical resistance, dimensional stability and strength-to-weight ratios three times higher than metals.

Ceramic matrix composites are used to provide organic materials with properties to compete with or out-perform metals at high temperatures. Ceramic matrix composites have many of the desired properties of the monolithic ceramics, but also are tougher, particularly in dynamic applications. Other examples include metal-matrix composites and ceramic coated materials.

The development of structural ceramic materials began in the 1960s and was largely motivated by the possibility of substantially improving the performance of gas turbines by raising their maximum operating temperatures. In the 1970s, several major U.S. Department of Defense (DoD) and Department of Energy (DoE) research initiatives explored and advanced the experimental fabrication and utilization of advanced ceramics in gas turbines.

Similar work continued during the 1980s with a variety of government-sponsored advanced gas turbine programs including: DoE's Advanced Turbine Technologies Applications Program (ATTAP), Ceramic Technology for Advanced Heat Engines program (CTAHE), and the Continuous Fiber Ceramic Composite program (CFCC); DoD's Integrated High Performance Turbine Engine Technology initiative (IHPTET); and the DoD/NASA National Aerospace Plane (NASP).

DoE also sponsors programs for the development of advanced ceramics in energy recovery uses, including ceramic recuperator programs that began in the 1970s. DoE currently has new high pressure heat exchange programs, as well as the CFCC, that will help develop composite design and processing technologies for a variety of industrial applications, including industrial turbines, heat exchangers, pollution abatement and waste recovery. Other advanced ceramic programs at DoE include solid oxide fuel cells (monolithic and tubular), high temperature ceramic filters for highly efficient gas clean-up systems, and high temperature superconductivity.

CURRENT AND FUTURE MARKETS FOR ADVANCED CERAMICS

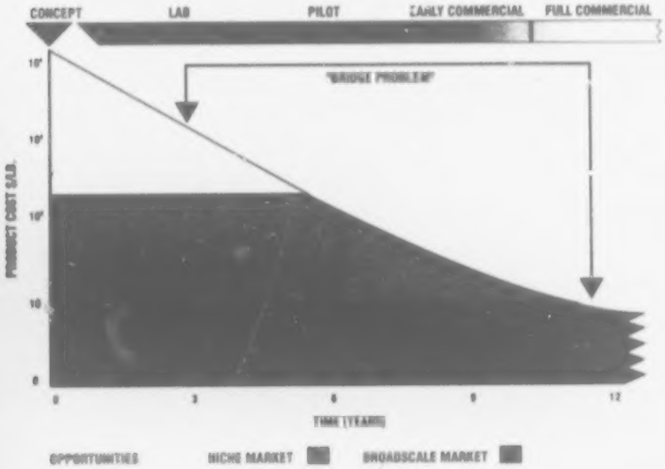
- **Aerospace**
    - advanced electronics
    - bearings
    - combustors
    - fuel cells
    - fuel systems and valves
    - high temperature auxiliary power units, low weight components for rotary equipment such as starters
    - seals
    - structures
    - thermal protection systems
    - turbine engine components
- **Automotive**
    - advanced reciprocating engines
    - advanced rotary regenerators
    - catalytic converters
    - drivetrain components
    - electronic substrates
    - fixed boundary recuperators
    - fuel injector components
    - low heat rejection diesels
    - turbines
    - turbocharger rotors
    - valves and valve seats
    - waterpump seals
- **Bioceramics**
    - artificial teeth, bones and joints
    - heart valves
- **Chemical Process Industry**
    - catalysts and igniters
    - mechanical seals
    - nozzles
    - radiant tubes and burners
    - recuperators
    - reformers
    - refractories
    - valve components
- **Defense**
    - armor
    - bearings
    - engine combustor sections
    - gun barrel liners
    - improved armor
    - optics
    - rocket nozzles
    - SDI (optical/heat transfer properties)
    - submarine shaft seals
    - tank power trains
- **Electric Power Generation**
    - bearings
    - ceramic gas turbines
    - cogeneration
    - filters (gas clean-up)
    - fuel cells (solid oxide)
    - high temperature components
    - reactor pump seals
- **Electronics**
    - advanced multilayer integrated packages
    - electro-optic packaging
    - multilayer capacitors
    - optical wave guides
    - pressure and gas sensors
    - semiconductor packages
    - substrates
    - superconductors
- **Environmental**
    - advanced components and systems for environmentally harsh processes
    - filters and scrubbers
    - incinerator liners and after-burners
    - radiant burners and boilers
    - wastewater treatment
- **Metals Processing**
    - boats
    - burners
    - crucibles and ladles
    - cutting tools and dies
    - insulation
    - molten metal filters
    - seeded gel abrasives for metal/ceramic finishing
- **Oil Industry**
    - bearings
    - blast sleeves
    - flow control valves
    - pumps
    - refinery heaters

WHAT IS THE BRIDGING THE GAP INITIATIVE?

The domestic advanced ceramics industry faces an uphill battle against stiff foreign competition. The time between research and development and the commercialization of ceramic products is far more than 10 years (see graph below). Therefore, bridging the gap from the laboratory to the marketplace requires an enormous investment of capital, making economics the major stumbling block to commercializing ceramic technology. Also, the cost of capital is currently very high at a time when the short-term paybacks are low. In addition, few incentives exist to help accelerate the use of ceramics or to invest more money in research. This makes it difficult for industry to justify such huge expenditures.

USACA therefore began work in 1988 to identify ways that could bridge the gap between basic research and development and the ultimate commercialization of advanced ceramic products. This culminated in the creation of the six-point Advanced Ceramics Development and Commercialization Program, better known as the Bridging the Gap Initiative.

TYPICAL ADVANCED MATERIALS LEARNING CURVE



BRIDGING THE GAP: POINT ONE

CREATE MULTI-YEAR FEDERAL CERAMIC COMPONENTS DEMONSTRATION PROGRAMS THAT WILL SUPPORT THE DOMESTIC DEVELOPMENT, MANUFACTURE, PURCHASE AND IN-USE DEMONSTRATION OF ADVANCED CERAMIC COMPONENTS AND PARTS OVER A FIVE-YEAR PERIOD. THIS PROGRAM SHOULD TARGET MILITARY AND COMMERCIAL ADVANCED CERAMIC AREAS, INCLUDING AUTOMOTIVE, AEROSPACE STRUCTURAL, AEROSPACE PROPULSION, ELECTRONICS, MACHINE TOOLS, ADDITIONAL WEAPONS SYSTEMS, COMPONENT APPLICATIONS AND INDUSTRIAL PROCESS EQUIPMENT.

BACKGROUND

Federally funded ceramic component demonstration programs are critical to the continued viability of our domestic advanced materials industry. In addition to providing badly needed niche markets, such programs generate the manufacturing, quality and performance data that are essential to the broadscale commercialization of advanced ceramics technology.

The Departments of Energy (DoE), Defense (DoD) and Commerce (DoC) sponsor a number of programs designed to develop and demonstrate advanced ceramics. At DoE, the ATTAP and CTAHE programs are focused on the demonstration of ceramic technology in gas turbine, spark ignition and other engines for automotive applications.

DoE is also sponsoring the CFCC program which is designed to enhance the energy efficiency of industrial process and energy conversion equipment through the development and demonstration of this new class of advanced ceramics. In the area of monolithic ceramics, DoE is funding development of Monolithic Solid Oxide Fuel Cells (MSOFCs) which efficiently convert energy into electricity and power vehicles with significantly reduced air emissions. All of these efforts are cost-shared by their industrial participants.

The DoD's work in advanced ceramics occurs in three major programs: the IHPTET and NASP programs and the Defense Advanced Research Projects Agency (DARPA) Materials and Electronics budget line. The IHPTET and NASP programs are attempting to incorporate monolithic ceramics, ceramic-matrix and metal-matrix composites into the next generation of aerospace engines and structures, but funding limitations are not permitting sufficient opportunity for materials development.

DARPA's Materials and Electronics budget is divided among a number of programs, including the development of ceramic-matrix components for electronic packages and metal-matrix composites for various military applications.

DoC sponsors a number of programs that are designed to produce the necessary databases, test methods and powder characteristics for advanced ceramics.

While actively supporting these programs, USACA also encourages the establishment of additional federally funded activities in areas with extremely strong military and commercial benefits. Specifically, USACA believes the technology developed in the ATTAP and CTAHE programs should be transferred to full-fledged demonstrations of ceramic gas turbine engines and other ceramic components in automobiles and in aerospace applications. Large-scale fleet demonstrations are the final steps required to enable the transition of advanced ceramics technology from the laboratory into mass-produced commercial systems.

USACA is also urging the creation of a Ceramic Insertion Program (CIP) at DARPA. The CIP would be similar to a fleet demonstration, involving the qualification of advanced ceramic components in operating military systems. It too would generate the volume of quality and performance data required to speed the adoption of this critical technology by our armed forces.

The DoC's Advanced Technology Program also presents a number of opportunities to develop pre-competitive, generic advanced ceramic technologies.

RECOMMENDATIONS

- Continue support of the DoE-sponsored ATTAP, CTAHE and CFCC programs.
- Initiate a program for ceramics for other gas turbine applications, e.g., trucks, industrial cogeneration.
- Continue support for DoD-sponsored IHPTET, NASA and DARPA materials programs (including MSOFC, electronic packaging and others).
- Create a DARPA Ceramic Insertion Program.
- Continue support of the Department of Commerce's Advanced Technology Program.
- Establish a fleet demonstration of ceramic gas turbine engines and other components in automobiles.
- Establish a field demonstration of ceramic components in gas turbine engines for aerospace applications.
- Establish a fiber development program for the high-speed civil transport program.
- Establish an electronic packaging program.

BRIDGING THE GAP: POINT TWO

CREATE DEFENSE PRODUCTION ACT (DPA) TITLE III ADVANCED CERAMICS PROGRAMS. THESE PROGRAMS WOULD TAKE THE FORM OF PURCHASE COMMITMENTS (GUARANTEES) TO BUY CERAMIC COMPONENTS PRODUCED BY DOMESTIC ADVANCED CERAMICS MANUFACTURERS FOR INCORPORATION INTO VARIOUS MILITARY SYSTEMS.

BACKGROUND

The Defense Production Act was enacted to increase the capability of industry and infrastructure systems in cases where the free market cannot provide the required national security capability in a timely manner. Title III of the DPA provides long-term, cost-effective, economic incentives to encourage private sector investment through purchases or purchase commitments.

Title III purchases or purchase commitments are supply contracts designed to establish a secure source for products critical to the national defense. Through competitive contracting the DoD agrees to purchase a specified quantity of materials over a particular period of time at a pre-negotiated price.

Title III programs for advanced ceramics would reinforce privately funded manufacturing companies by developing production capabilities for defense systems. Without this incentive the current industrial base may not grow sufficiently to warrant further private commitment. The United States would then be required to rely on foreign sources for these critical materials.

A case in point is the ball bearings industry, which has been losing market share to foreign suppliers. Because they are critical components of a variety of military systems, it is in our national interest to ensure a domestic source of advanced bearings. One way to do this is via a DPA Title III program for ceramic bearings.

RECOMMENDATIONS

- USACA recommends that Title III programs be developed and supported for:

  - armor
  - ceramic bearings
  - ceramic fibers for high temperature composites
  - diesel and turbine-gas engine components
  - electronic packages
  - military aircraft propulsion system components
  - silicon nitride powder

BRIDGING THE GAP: POINT THREE

CREATE AND EXPAND INVESTMENTS IN DOMESTIC ADVANCED CERAMICS MANUFACTURING SCIENCE AND TECHNOLOGY PROGRAMS AIMED AT DEMONSTRATING COST-EFFECTIVE PRODUCTION AND REPRODUCIBILITY OF ADVANCED CERAMIC COMPONENTS FOCUSED UPON SPECIFIC REQUIREMENTS OF END-USERS.

BACKGROUND

Many of the critical powders and materials that are required for the production of advanced ceramics components and parts are not currently available in the U.S. and therefore require individual Manufacturing Science or Manufacturing Technology related efforts to develop prior to major production applications.

In addition, critical new families of materials are needed that can be supplied in cost-effective quantities. For example, ceramic fibers for moderate and high temperature applications will be required if those applications are to be successfully implemented. Fortunately, many of these materials have been produced in early stage research programs and now require only scaleup and cost reduction process (manufacturing) developments.

Additionally, new powder materials will be needed to provide cost-effective monolithic ceramics and new materials for ceramic-matrix composites. These processes must also be cost-effective.

An advanced ceramic manufacturing technology program that is currently needed is one that would reduce the cost of producing ceramic components for application in heat engines, which could greatly reduce exhaust emissions in today's vehicles. The U.S. automobile industry is prepared to introduce ceramic components, but near-term (less than five years) use requires substantial cost reductions for ceramic components. Most of the current government funded ceramic technology programs have a longer-range focus and emphasize high-performance goals of advanced engines. Cost reduction is not currently the primary focus.

The National Institute of Standards and Technology (NIST) at the Department of Commerce has a number of ongoing programs that can be instrumental in solving many of these problems, including standards, measurement methods, data and a quantitative understanding of advanced ceramics.

A national program is needed to develop low cost ceramics for near-term use in heat engines. Such a program would focus on ceramic machining and finishing, ceramic raw materials, alternative processes (low cost, net shape, process equipment automation development), yield improvement (SPC, intelligent processing), testing and performance standards, data base development, and technology transfer.

RECOMMENDATIONS

- Establish a Cost Effective Ceramics for Heat Engines program, with the objective of low cost, reliable ceramics for near-term applications in current gasoline and diesel engines.
- Continue and expand the current CTAHE program for ceramic processing and include actual component process development.
- Establish a NIST Advanced Technology Program for advanced ceramic rapid machining that would identify and address scientific and technical areas of concern, thus enhancing the ability of the domestic industry to produce quality advanced ceramic parts and components.
- Support the development of critical raw material process equipment for the production of fiber and matrix materials, and encourage the coordination of multiple government agencies to minimize process development overlap.
- Increase the Man-Tech and Man-Science programs in DoD to accelerate the evaluation and use of new composite materials, including their respective fiber and matrix materials.
- Select and support concurrent engineering goals for lowering the overall cost of materials and/or finished ceramic components for high volume applications that would tend to establish ceramics as economical alternatives, e.g., automotive engines, electronic packaging, armor, etc.
- Develop the associated manufacturing and testing equipment within the U.S. that will enable the large-scale use of ceramic-matrix composites.
- Continue support for NIST-sponsored advanced ceramic programs that develop standards, measurement methods, data and a quantitative understanding of advanced ceramics.

BRIDGING THE GAP: POINT FOUR

RECOGNIZE THE CAPITAL INTENSIVE NATURE OF THE ADVANCED CERAMICS INDUSTRY AND PROMOTE INDUSTRIALIZATION IN THIS AREA BY ALLOWING A MORE COMPETITIVE RETURN ON ADVANCED CERAMIC COMPONENTS PURCHASED THROUGH THE FEDERAL PROCUREMENT SYSTEM AND BY PERMITTING FIRST-YEAR WRITE-DOWN OF THOSE NEW CAPITAL INVESTMENTS MADE BY THE ADVANCED CERAMICS INDUSTRY DURING A 10-YEAR PERIOD.

BACKGROUND

It is in the best interest of the United States to have a strong, viable advanced materials industry, one that will achieve a global leadership position and one that attracts the financial support to sustain that leadership.

As the primary consumer of advanced materials, the government, and especially DoD, can set the tone for business in this arena. Recognizing what can be a confrontational rather than cooperative environment created by the many policies and regulations mandated for conducting business with the government, leaders across a broad spectrum of agencies have launched new initiatives to restore trust, foster growth and improve effectiveness. The advanced materials industry applauds initiatives such as a more flexible approach to contract awards, adoption of a total quality management philosophy with emphasis on producing and rewarding higher value and reliability, and curtailing inefficient micro-management practices.

New judgments are also being made concerning the economic benefits of competing on all contracts or requiring multiple suppliers. Most of the emphasis has been focused on prime integrators. This new practice needs to be extended into the advanced materials industry as well, due to the industry's distinctive characteristics

Significant changes are required to encourage the growth of the advanced materials industry in the United States. Fundamentally, the procurement system as it now exists sets up tremendous tension between the near-term requirements of industry to build and sustain an attractive business and the long-term benefits that the government and the nation enjoy as the result of successful commercialization of advanced materials technologies.

In key financial dimensions, the advanced materials industry differs from other sectors. Commercial-scale manufacture of advanced materials requires a very high ratio of capital investment to sales revenue, compared to most industries. Studies indicate that capital requirements for the advanced materials industry are twice those of the traditional fabrication and assembly functions of the prime integrators. For example, an examination of typical defense aerospace contractors shows a ratio of $1 of sales revenue for 50 cents invested capital, while for advanced materials manufacturers, this ratio is $1 of sales revenue for $2-$4 of invested capital. Further, all of the advanced materials investment must be made without ~~a~~ long-term commitment from the market.

Where the market is the government, the risk is further increased by the auctioning process of competitive bids. This takes place after years of qualifying the product and the facilities for use. In most cases the advanced materials facilities investment is made totally by the industry, unlike many examples of prime integrators receiving investment support from the government.

Meanwhile, as global competition heats up, the time period for expected corporate payback on investments in advanced materials technologies continues to shrink. Increasingly, companies seek to recover even capital-intensive investments in less than 10 years. The Office of Technology Assessment report on advanced materials, however, points toward a nearly 20-year period between development and commercialization of advanced materials. A similar study by the Air Force showed an average of nearly 15 years between development and Air Force adoption.

At the same time, government procurement is characterized by misplaced incentives. Rather than a reward system based on the free market-established value, it defines—and limits—profit to a fixed percentage above costs, and thereby drives participants to maximize costs. Furthermore, this pre-ordained profit level is based solely on typical low capital-intensive industries, but is applied equally to high capital-intensive industries. The result of these policies and regulations is an average after-tax profit margin of approximately 5 percent for defense contractors.

Furthermore, under present regulations, accelerated depreciation of capital investment is not permitted. Due to the capital-intensive nature of the advanced materials industry and the long lead times associated with these emerging technologies, the government should permit accelerated depreciation of rates on capital invested in technologies identified as critical to national interests. This accelerated depreciation of manufacturing equipment could take the form of a maximum three-year write-down of new investment instead of today's six-year depreciation for tax purposes. This would reduce the financial penalty inherent in investment for new high risk technologies and provide a more acceptable corporate return on that investment over the short term.

In addition, profitability of the ventures must be considered because these limits on profitability do not currently create the necessary incentives to allow a reasonable return on investment or minimum payback periods due to the high costs associated with advanced materials development. For example, in competitive commercial business, advanced material products would return at least 12-14% on investment to be attractive to industry. Many businesses have returns higher than this, based on perceived value. By permitting industry to obtain satisfactory financial returns related to the cost of capital and not just direct development or production costs, the strength of the advanced materials industry will be enhanced to the benefit of the United States.

Also, military demand for high performance weapons systems has played a dominant role in the development and commercialization of advanced materials and products. Such defense-sponsored development, however, is most often a "specific solution" tailored narrowly to a specific weapons system. The choice of materials, design and fabrication into components are unique and limited to the application.

In the past, the assumption has been that industry can enjoy commercial prosperity from its early investments in less lucrative defense applications. This is no longer true. However, if government agencies other than Defense also demonstrate financial support and join in a national drive to accelerate advanced materials, industry would flourish and the entire country would enjoy benefits in many areas: environment, industrial competitiveness, deficit reduction, employment, balance of trade and defense.

While maintaining sufficient funding to develop necessary weapons systems for national defense, efforts must be made to identify funding for developing advanced materials by other government agencies. Funding should be increased in agencies which explicitly support commercial, public uses. These agencies should be charged with developing the broadest possible use of advanced materials to address the nation's environmental, social and economic interests. Departments include Energy, Transportation, Commerce, Interior, and Health and Human Services, as well as the Environmental Protection Agency.

A national priority to expand government support for growth of the advanced materials industry will raise the national awareness and promote earlier adoption of these materials, expand the markets for products made with them, accelerate the U.S. industry leadership and secure the broadest societal benefits from these technologies.

The public imagination must be stimulated in order to relate advanced materials benefits to personal lives. Government agencies can assume roles beyond their current ones — and coordinate policies and actions — to help foster such public engagement.

RECOMMENDATIONS

- Government should permit accelerated depreciation rates on capital invested in technologies identified as critical to the national interest.
- No artificial limit on profitability should be set by the government.
- Industry should be permitted to obtain satisfactory returns related to the cost of capital and not just direct development or production costs.
- Establish a coordinated multi-agency program that will demonstrate ceramic engine technology and help create a performance data base.
- Create a coordinated multi-agency program that will fund advanced materials programs throughout the government to address the specific needs of those agencies.

BRIDGING THE GAP: POINT FIVE

PROVIDE TAX INCENTIVES, SUCH AS GOVERNMENT-FUNDED REBATES, FOR DOMESTIC ADVANCED CERAMIC END-USERS WHO INCORPORATE ADVANCED CERAMIC COMPONENTS IN PRODUCTS AND DEMONSTRATION PROGRAMS DURING THE NEXT DECADE, SO AS TO PROVIDE USER "PULL THROUGH" TO THE U.S. ADVANCED CERAMICS INDUSTRY.

BACKGROUND

Many companies in the user community face situations where the initial costs for ceramic components are not competitive with alternate materials/designs that offer adequate performance. However, in a number of cases, there is an excellent chance that, given the experience and economics of scale, the cost-performance balance could shift in favor of advanced ceramics. For example, given the extreme competitiveness within the U.S. automobile industry, the cost of any component considered must be the lowest possible.

Therefore, incentives to the U.S. user industries would provide a means to supplement the increased near-term cost of introducing ceramic components in high-volume applications. Once in volume production, the ceramic industry would be in a position to realize economies of scale through (for example) high-volume, lower-cost procurement of raw materials, real time process optimization and reduced inspection costs through increased confidence in process capability.

RECOMMENDATION

- Tax incentives should be created for early introduction of ceramics in proportion to the cost differential realized when compared with conventional materials/designs. Participation should be limited to U.S. end users with products purchased from U.S.-based ceramic companies.

BRIDGING THE GAP: POINT SIX

MANDATE THE VESTING OF TECHNOLOGY RIGHTS IN ADVANCED CERAMICS TO DOMESTIC ADVANCED CERAMIC MANUFACTURING CONTRACTORS WHEN THEY PARTICIPATE IN R&D, MAN-TECH AND DEMONSTRATION PROGRAMS ON A COST-SHARED BASIS, IN ORDER TO ATTRACT AND PROMOTE THE MOST COMMERCIALLY ATTRACTIVE AND INNOVATIVE TECHNOLOGIES IN THESE EFFORTS.

BACKGROUND

USACA believes the goal of the U.S. government should be to develop and advance the U.S. technological position relative to other world powers by funding research and development. However, current policies result in the inefficient use of government R&D funds. Although the government promotes the development of a strong industrial base, its aggressive efforts to obtain technical data and patent rights reduce the quantity and quality of inventions or technical innovations. Contractors are frequently requested or required to share in the development costs while having to give up some or all of their rights in the technology developed. As a result of this increase in cost-sharing, certain agencies (such as DoE) allow the contractor to retain patent rights. All agencies should grant contractors the right to take ownership of inventions under the authority of the Bayh-Dole Act.

The government's desire to acquire rights to technology developed with government funds discourages government contractors from inventing with government funding due to the resultant restricted ability of the contractor to benefit commercially from such inventions. Therefore, the number of inventions actually realized through the use of government funds is significantly reduced. In addition, it is likely that only the highest risk ideas (i.e., those with least probability for success) and lower risk ideas (i.e., those with small opportunity for invention) will be explored by government contractors, which also reduces the number of inventions realized by federally funded R&D. Moreover, the sheer size of the bureaucracy and paperwork involved with government contracts sharply reduces the productivity of R&D.

The value received by the government for R&D expenditures may be further diminished by examining the quality of inventions which result from government R&D funding. Specifically, government contractors are discouraged from pursuing their best technical ideas because the government desires to acquire rights to technology.

Thus, the quality of inventions that do result from government R&D funding may not parallel the high quality of inventions achieved with private R&D funding. Accordingly, the real value obtained by the federal government for each dollar spent may be even further diminished.

In addition, some private companies fear the development of a working relationship with the government due to the possibility of losing rights to their own technology. Currently, a constructive reduction to practice (filing of a patent application) alone, prior to entering into a government contract, is not sufficient to avoid having the invention deemed a subject invention. This provision is a significant disincentive for private industry to enter into any type of government contract where the concept has not completely been proven. Thus, the government may actually be isolated from exposure to and application of certain technologies which may be critical to government needs because the most viable technology that a private company may have may not be utilized in a government contract because of the fear of loss of rights to it.

By changing the definition of subject invention to include reference to a constructive reduction to practice, the incentive for private industry to enter into a contract with the government would be increased.

RECOMMENDATIONS

- Mandate the vesting of technology rights in advanced ceramics to domestic advanced ceramic manufacturing contractors when they participate in R&D, Man-Tech and Demonstration programs on a cost-shared basis.

- Waive government license rights to all emerging technologies where it is determined at the time of contracting that the interest of the U.S. and the general public will be better served thereby.

- Expressly include an exemption (except in cases of national security) from government license rights where significant private funding has already been expended and the government is attempting to build upon that privately developed technological base of information.

- Clarify the FAR regulations to ensure that any developments made by a contractor during the course of performance of a government contract, and which are made with private or independent research and development funds, do not constitute subject inventions.

- Change the definition of "subject invention" to include reference to a constructive reduction to practice.

- The government should also have "march in" rights where the contractor does not perform and where government funds are directly involved, but it should not have such rights under collaborative efforts where no funds are exchanged.

Senator SHELBY. Thank you.

To what extent do your respective companies make use of the labs, and how would a decision to use a lab in a particular area come about?

Dr. WILKS. I will go first.

Senator SHELBY. Either one of you or both.

Dr. WILKS. We use the national laboratories in a number of different ways. We are members of the high temperature materials lab group down at Oak Ridge. We are active members at the Brookhaven National Laboratory synchrotron light source. We are charter members to be, if you will, when the advanced photon source at Argonne comes up. We have created initiatives and have co-worked on programs with people at Los Alamos. We have also done some programs with Argonne National Laboratory. Our aerospace arm of the corporation also has interactions with the national laboratories, many of which I am not aware of the details of.

Senator SHELBY. Dr. Owczarski?

Dr. OWCZARSKI. We are also quite active in our interactions with the Federal laboratories. We are at least involved in one of the CRADA's with Argonne National Laboratory that I am specifically involved with. They are in the process of negotiating another one with Lawrence Livermore and are working in less formalized relations with Sandia in Albuquerque and INL and a number of other places. We work with NIST on a number of programs, and certainly are not only actively involved, but trying to find more efficient ways of getting even more involved. We are in the process now of forming a corporate committee to try to take representation from individual operating divisions and form kind of a search operation, if you will, to find the places where we can take advantage of the activities with the national labs. So, I think in that sense, we certainly have a fair amount of experience and are looking for ways of expanding that.

Senator SHELBY. Thank you.

I have a number of questions that I would like to submit to you for the record that we would hope you would answer in detail to help all of us on the committee.

Dr. OWCZARSKI. I would be happy to.

Senator SHELBY. Senator Bingaman?

Senator BINGAMAN. Thank you very much, Mr. Chairman.

Dr. Owczarski, let me ask. You have a very interesting statement in your testimony where you say that, "the Federal technical establishments are independently strong, but collectively mediocre." Maybe you could just elaborate on that a little bit.

Dr. OWCZARSKI. I guess what that was intended to say, Senator, is that in the context of what we could do together, we have not reached a level of excellence. Certainly there is a great sense of excellence within the national laboratories. There is also a great deal of excellence in our university system, and there is a great deal of technological and engineering excellence in our industrial laboratories. Together in terms of collaborative ventures, we have not yet reached the same level of excellence.

Senator BINGAMAN. Dr. Wilks, the United States Advanced Ceramics Association is a relatively new organization, is it not?

Dr. WILKS. Yes.

Senator BINGAMAN. And you have 30 members you indicated.

Dr. WILKS. Yes.

Senator BINGAMAN. How does that compare with the sister industry organizations that exist in Europe and in Japan, for example, in the area of advanced ceramics?

Dr. WILKS. I cannot provide you that detail off the top of my head. I will be happy to provide it to you.

The impression I have is that when it comes to those sorts of formal organizations and interactions, we are being outdone.

Senator BINGAMAN. That is my impression too. Particularly in Japan, I think they have a much longer established and much larger organization as far as membership.

Has your organization made a determination not to include governmental members? Would it make any sense to have Oak Ridge or any of the laboratories as members of an organization like yours, or does that just not make any sense?

Dr. WILKS. It would certainly invite partnership. I cannot tell you any formal reason why they could not be partners. I think that the intent of the organization when it was formed was one that was driven by potential producers or users of high technology ceramics, but there is no reason in my view that a national laboratory could not and perhaps should not be a member of that organization.

Senator BINGAMAN. Let me ask just the question that I asked to the previous panel, a little bit on the international issue. I know United Technologies has taken quite an interest in the IMS proposal on intelligent manufacturing systems that the Japanese have proposed to both ourselves and to the Europeans.

Have you thought at all, or are you involved in that issue? Do you think that the Department of Energy should take an active role in determining the U.S. response to that proposal or perhaps they have? What could you suggest relative to what we are talking about here and the capabilities in the national labs related to those kinds of international cooperations?

Dr. OWCZARSKI. Let me try to answer it this way, Senator Bingaman. I have been involved with much of the activities to follow-and track and try to help contribute to both our company's position and to try to provide suggested information to the Department of Commerce, which has been the lead organization to try to respond to the IMS proposal that the Japanese made a couple of years ago. Our company is certainly interested in it because we recognize that the way the world is going, the world is a growing total market, and we must participate in that market, and that simultaneously there are areas of technology around the world that are very well recognized as being as good as ours, in some cases better. Certainly manufacturing is one great skill capability that the Japanese have demonstrated in many of its products. In that general sense, to become involved whenever IMS really becomes a program would be something that we would look forward to as a possibility. As you know, the definition of what IMS might become has still not been made. We are following it with great interest and hope that opportunities do come forth from that.

As far as the potential role of the energy labs, I am not in detail familiar with what degree of communication they have with the process that is ongoing, and I think it would be better to think that when IMS becomes defined in terms of what it will address, what it will not address, and what is appropriate for international collaboration, and what might be appropriate for, let us say, a domestic agenda for intelligent manufacturing, that there would be potential opportunities for them to play a significant role. But I do not know how to define that until the program gets defined.

Senator BINGAMAN. That is all I had, Mr. Chairman. Thank you very much.

Senator SHELBY. I just want to ask you an overall question. It at least seems to me at times that the Japanese are dominating the electronics industry, at least a part of it. It feeds into everything. If we do not come to terms with that—I am talking about our industry, our labs, our technology. You know, we discover things and then they apply it or they reduce it to a denominator that has mass application. And we are not players in it anymore. You can name them better than I can because you all are scientists. But I see that as a tremendous threat to us in the future even if not now. The automobile has changed so much, so many microelectronic processes going into it more and more, and so many things we are importing that we do not make. I am sure that is just part of what we are talking about.

I know Senator Bingaman chairs a subcommittee which deals with these same issues on the Armed Services Committee, in addition to sitting on this committee, and I also serve with him on the Armed Services Committee. He is deep into this subject and concerned about where we are going. Hence, this legislation he has introduced.

Do you share my overall concern of what we are losing and how we are losing it?

Dr. OWCZARSKI. I could certainly share concern about the challenges that are out there. I think one of the comments that came out of some discussions that we had both within our committee at NAM and in our company. When IMS first came upon the scene a couple years ago, we sort of coined the phrase "This is another wake-up call."

Senator SHELBY. But how many is it going to take?

[Laughter.]

Dr. OWCZARSKI. Perhaps it is why we are so interested in being very close to that program among others. Perhaps it is why we are very much concerned about working very hard both in an investment sense in keeping our own technology base as high as possible and being very watchful about that challenge, that threat, and hopefully converting it into an opportunity.

Senator SHELBY. If we do not heed the wake-up calls if there is one, two, three wake-up calls, pretty soon the meeting we were supposed to go to or participate in is over, is it not? We are lost. So, you can only have so many wake-up calls.

Dr. Wilks?

Dr. WILKS. I would agree with those comments pretty much. A wake-up call is a good analogy for what we have seen.

I think that what we are talking about today is something that can make some difference here. One of the keys that we have to really get our hands on to really compete in this new rapidly developing technological global marketplace is shortening the time from an idea to the marketplace because he who gets there first with something that is acceptable is tough to displace. And that is where we lose out quite often. We can talk about long range versus short range and a lot of other topics, but that is really the key point.

I would commend DOE, if you will, for the fact that they have put in place a technology organization that has skill bases I think that will be very critical for this. And what I am talking about there is the huge, powerful computing network that exists in the national laboratories and the people who are skilled in the use of those machines. That is a national asset, and that needs to be tied into this because you can do so much so much more quickly with those kinds of tools. Unfortunately, at this moment in time, those tools are not available to the U.S. industry in general. We have an asset there and we have an opportunity area.

Senator SHELBY. Thank you.

Do you have any other comments?

Senator BINGAMAN. I do not.

Senator SHELBY. Gentlemen, I appreciate your coming, and we will look forward to the detailed answers to these other questions. Thank you a lot.

This concludes the hearing.

[Whereupon, at 3:55 p.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

DEPARTMENT OF ENERGY,
CONGRESSIONAL AND INTERGOVERNMENTAL AFFAIRS,
Washington, DC, August 14, 1991.

Hon. WENDELL H. FORD,
Chairman, Subcommittee on Energy Research and Development, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

DEAR MR. CHAIRMAN: On June 27, 1991, Cherri J. Langenfeld, Director of Technology Analysis, Office of Policy, Planning and Analysis, testified before your subcommittee on S. 979, the "Department of Energy Critical Technologies of 1991."

Following the hearing, you submitted written questions on behalf of yourself and Senator Bingaman to supplement the record. Enclosed are the answers to those questions.

If we can be of further assistance to you or your staff, please contact our Congressional Hearing Coordinator, Barbara Barnes, on (202) 586-6341.

Sincerely,

DEBORAH L. LOUISON,
Principal Deputy Assistant Secretary.

[Enclosures.]

QUESTIONS FROM SENATOR FORD

Question 1. You mentioned in your testimony the institutional planning process as one of the mechanisms the Department uses to help plan and coordinate its technology activities. How exactly does that process work and do all of the laboratories make use of it to the same degree?

Answer. The institutional planning process is a management tool for DOE planning and oversight of its contractor operated laboratories. It defines, in broad terms, the current and future direction, missions, and programmatic areas of each laboratory. The process works in the following way. Based on broad Secretarial guidance and individual programmatic guidance, the laboratory develops a draft plan. Senior departmental and contractor management review and react to issues, initiatives, and program direction included in the draft plan at an annual on-site meeting. A final plan is then prepared by the laboratory and approved by Department.

DOE SUPPORT OF CRITICAL TECHNOLOGIES

Question 2. Is there any one document that the Department produces that would tell me how and to what extent the Department and its labs support all of these different critical technologies?

Answer. The Department's annual budget submission is the primary control document for all of the research and development activities of the Department of Energy. Prior to preparing the budget request, the Department attempts to balance all of its mission responsibilities, including its major responsibilities in energy research and development, basic scientific research, national security, and technology transfer, through a year-long integrated planning and budgeting process. Each of these major mission responsibilities involves support for many of the critical technologies identified in the Report of the National Critical Technologies Panel.

For example, the Department's mission in energy technologies (one of the six categories of critical technologies) involves support for advanced transportation technologies (another of the six categories of critical technologies). Within the transportation arena, DOE supports research in advanced materials, such as ceramics (another of the six categories). Similarly, the Department's program in industrial energy technologies supports research in advanced materials processing. The Department also supports fundamental research in these same areas, such as the materials sciences research under the Basic Energy Sciences Program of the Office of Energy Research.

The budget document is driven by a number of important planning documents. For example, the Department's major mission in energy technologies is supported by the National Energy Strategy. The Department's mission in environmental restoration is supported by the Environmental Restoration and Waste Management five-year plan. The Department's activities in high-performance computing are guided by the report of the Federal Coordinating Committee for Science, Engineering, and Technology (FCCSET).

Each of these specific programs is detailed in the annual budget submission. Although the budget submission is not organized by the exact categories of technologies that are contained in the Report of the National Critical Technologies Panel, the budget, none-the-less, provides an integrated view of how and to what extent the Department and its laboratories support these various technologies.

Question 3. Does the Department believe that the laboratories should begin to develop expertise in areas of technology they are not currently doing work in or that they should simply build more on existing areas of expertise?

Answer. The laboratories already have broad capabilities in many technical subjects that can be applied beyond the energy and defense responsibilities of the Department. For example, the Department and the Nation need to develop technology for environmental restoration and waste management. Laboratory capabilities in this area can be strengthened beyond the research stage and applied to the development of advanced technology. In some cases technology research and development may require that the laboratories move into new technical areas, and they normally do so when it fits the missions of the Department and satisfies a national need.

There are other ways in which the laboratories expand their capabilities into new areas, such as through the Laboratory Directed Research and Development activities of the laboratory. The new Cooperative Research and Development Agreement (CRADA) process will also contribute to this expansion, as the laboratories increase their interactions with industry in a variety of technology areas.

The Department is currently evaluating future roles and missions of the laboratories. A Secretary of Energy Advisory Board report, expected later this year, will consider this issue.

Question 4. The Department has a number of mechanisms available to it to work with industry such as Cooperative Research and Development Agreement or the User-Facility Agreement. Briefly describe how those different mechanisms work and whether they are adequate for the kind of work the Department would like to do with industry?

Answer. The Department and its management and operating (M&O) contractors have many mechanisms to work with industry, including the two named in the question, ranging from Federal acquisition contracts for procuring work defined by the Government to Work for Others agreements to perform work defined by industry at Department facilities, and Federal financial assistance awards (grants, cooperative agreements) to support research within industry. The following is a list of such mechanisms and a summary of their characteristics.

Federal Acquisition Contracts: The work scope is defined and the work funded by the Department or its M&O contractor (in the latter case, the contract would be a "federal acquisition subcontract"). The work is performed by either an M&O or a non-M&O contractor. Results of work are made available to the Department and, to the extent results are not classified, proprietary to the non-M&O contractor or subject to intellectual property protection, are made available to the public. Resulting intellectual property may belong to either the M&O or non-M&O contractor or the Government. The contractor(s), Department and public have access to new technology developed. The terms and conditions of the contract are largely mandated by statute and determined by Government regulations.

Technical Support Services Contract/Consultant Agreements: A subset under contracts where work is performed usually by an individual for the Government.

Cost Shared Contracts: The work scope is defined and the work funded both by the contractor and the Department (or its M&O contractor). The work is performed by a non-M&O contractor. Results of work are made available to the Department and, to the extent results are not classified, proprietary to the non-M&O contractor or subject to intellectual property protection, are made available to the public. Resulting intellectual property in many instances belongs to the non-M&O contractor. The contractor(s) and, to a lesser extent, the Department and public have access to new technology developed. The terms and conditions of the contract are largely mandated by statute and determined by Government regulation.

Financial Assistance—Cooperative Agreements/Grants: The project description is typically defined by the recipient and the work funded by the Government. The effort for a grant is performed by the recipient. The effort for a cooperative agreement is performed by the recipient with substantial involvement by the Department and/or its M&O contractor. A nonproprietary report describing the work is made available to the public and Government. Results of the work are made available to the Department, and to the extent results are not classified, proprietary to the recipient or subject to intellectual property protection, are made available to the public. Resulting intellectual property in most instances belongs to the recipient. The terms and conditions are more flexible and less detailed than those for contracts. Where substantial involvement by the Department is required, the instrument is called a cooperative agreement.

Cooperative Research and Development Agreements: This type of agreement is a statutory cooperative agreement having similar characteristics as other cooperative agreements, except that the process of selecting participants is more streamlined. The agreement is entered into between an M&O contractor or a Government operated laboratory and a recipient. The M&O contractor or Government laboratory can make special provisions for sharing intellectual property rights, for protection of technical data from early publication and for royalty sharing. The other terms and conditions of these agreement are also more flexible than for other agreements and contracts.

Small Business Innovation Research: These are a special class of Federal awards limited to small businesses and having special statutorily defined terms.

Licensing: These agreements are formal permission to commercially use DOE-developed intellectual property, in return for commitment to develop and market the technology at private expense and, usually, payment of royalties.

Proprietary User Facility Agreements and Work for Others Agreements: The work scope is defined and the work fully funded by the sponsor and performed by the Government laboratory. A nonproprietary report describing the work is made available to the public and Government. Resulting intellectual property in most instances belongs to the sponsor. The terms and conditions are more flexible and typically less detailed than those for contracts.

Nonproprietary User Facility Agreements: These agreements are the same as proprietary user facility agreements except that the funding may not cover all overhead costs. The results of the work performed are fully published.

International Agreements: The work scope to be performed by each participant country or its representative is defined by mutual agreement between the countries. Normally, some or all of the work is performed in the country funding the work. Resulting intellectual property is owned and licensed in accordance with each agreement and the national laws of the participating countries. Usually, the agreement provides for a report describing the work performed to be published.

Personnel Exchanges: The work scope is defined and the work funded mutual agreement. Resulting intellectual property is generally owned or controlled by the organizations supplying the individuals. Results of work are generally governed by the host organization policies and procedures. The terms and conditions are flexible.

Personnel Assignments: The work scope is defined by the host organization and the work funded by either the Government or assigning organization. Resulting intellectual property is generally governed by the host organization's policies and procedures.

The above mechanisms are used by the Department and its M&O contractors in working with industry. They cover a wide range of circumstances and are considered adequate by the Department at this time.

Question 5. Does the Department involve industry in establishing the research and development agendas for each of the laboratories? If so, how,? If not, why not?

Answer. The Department strongly encourages the involvement of industry in the establishment of the research and development agendas for its laboratories. This is approached in several ways. As previously mentioned in the response to question 3, the Secretary has requested a Secretary of Energy Advisory Board review and recommendations on future research and development roles and missions for its laboratories. A key aspect of this review is the involvement of industry members on the review teams. Additionally, each of the multiprogram laboratory contractors utilizes senior advisory committees which include industry representation for input on such things as the laboratory's research agenda.

QUESTIONS FROM SENATOR BINGAMAN

Question 1. One purpose of the Council is to coordinate critical technologies research and development with industry and other federal agencies. In your statement, you have said that there is already a process in place to do this. Could you elaborate on the process, and specifically, on how research and development efforts in various critical technologies are coordinated across each of the Department's offices (waste management and environmental restoration, energy research, and defense programs) and among the other agencies?

Answer. Coordination with other agencies is done in general by discussions among high-level officers of the agencies and in detail by interagency committees. For example, technology initiatives in the National Energy Strategy were coordinated through the Economic Policy Committee and its working groups. An additional example is the Committees of the Federal Coordinating Council on Science, Engineering and Technology (FCCSET), which are an important mechanism for detailed interagency discussions in high performance computing, global climate research, biotechnology, and many other issues facing the nation in science and technology. In addition, advice and coordination is obtained through DOE advisory committees and through the National Academy of Sciences (for example, the National Materials Advisory Board, the Solid States Sciences Committee, and the Board on Physics and Astronomy).

Within the Department, coordination is established by program planning discussions among senior technical staff, by formal coordinating committees, and through the extensive working relationships that exist among science and technology staff. For example, materials R&D covers several of the critical technologies from the National Critical Technologies Listing (materials synthesis and processing, electronic and photonic materials, ceramics, composites and high-performance metals and alloys). Within DOE, materials R&D is coordinated through the DOE Energy Materials Coordinating Committee (EMaCC) which has members from all of the DOE materials R&D units. Across the Agencies, the OSTP Committee on Materials (COMAT) coordinates materials R&D. The COMAT has specific Working Groups on Superconductivity and Ceramics, for example. In addition, each of the DOE Laboratories have Advisory Committees for each programmatic activity which include representatives from industry, universities and other laboratories.

Qestion 2. Another purpose of the Council is to serve as a point of contact for international cooperative science and technology efforts. You have stated here that "the Department" is pursuing appropriate collaborations with international participants. These are coordinated with the State Department, the Office of International Affairs and Energy Emergencies and the specific program offices.

This doesn't sound like an organization with a point of contact. How are these efforts coordinated? How are appropriate collaborations identified? How many Departmental personnel billets are assigned to international collaboration?

As I recall from my trip to Japan last November, there is only one representative from the Department in the U.S. Embassy in Japan, and all of his time is taken up with soliciting funds for the SSC. Does the Department consider this appropriate? Who in the Department has responsibility for evaluating Japanese efforts and determining whether collaboration would be in the best interests of the U.S.?

Answer. Within the Department of Energy, the Assistant Secretary for International Affairs and Energy Emergencies (ASIE) serves as the principal coordinator for DOE-wide international agreements. The office of the ASIE develops, in coordination with the appropriate program offices, the policies as well as procedures for international agreements for scientific and technical cooperation to which DOE is a party. This authority derives from Section 31 of the Atomic Energy Act of 1954, as amended and Sections 103(10) and 107(a) of the Energy Reorganization Act of 1974. In addition, Section 102(10) of the Energy Reorganization Act authorizes the Department of Energy to undertake international energy activities in coordination with the Secretary of State.

International cooperative scientific and technical programs usually originate within the DOE program offices after determining the need for and assessing the benefits of cooperating with a specific country or group of countries such as the International Energy Agency. Currently, all proposed new international agreements or those up for renewal are approved by the Deputy Secretary of Energy prior to execution. In addition, such agreements are subjected to an interagency review process, coordinated by the Department of State. This action, referred to as a request for Circular 175 Authority, precedes negotiations with the partner country or group of countries.

There are approximately 25 full-time professional and secretarial staff involved with international cooperative activities. Duties range from assessment of technologies, assessment of benefits of cooperation, negotiation, administrative management, execution of cooperative activities and evaluation.

The major responsibility of the DOE Representative in Tokyo is to provide on-site link to Japanese scientific and technical programs in which DOE collaborates or has an interest. This responsibility goes considerably beyond SSC, covering nuclear energy, fossil energy, renewable energy, energy efficiency, fusion energy, basic energy sciences, and high energy physics. Only recently has the DOE Representative in Tokyo spent considerable time on SSC matters, gauging and reporting on Japanese interest in participating in the project rather than soliciting funds for it.

As noted above, the DOE program offices, in consultation with the Office of International Research and Development Policy, ASIE, are responsible for evaluating foreign scientific and technical programs—including Japan—and recommending to the ASIE and Deputy Secretary the programmatic benefits to be derived from cooperation. These actions are in conjunction with the aforementioned Circular 175 authority.

CRITICAL TECHNOLOGIES COUNCIL/ADVISORY BOARD

Question 3(a). The purpose of the Advisory Board is to provide industry input on the Department's critical technology planning. What mechanism does the Department have for eliciting and responding to industry input on its research and development plans for technologies that are critical to economic competitiveness?

Answer. A significant amount of research and development (R&D) addressing DOE's critical technologies takes place in the offices of Fossil Energy (FE), Conservation and Renewable Energy (CE), Defense Programs (DP) and Energy Research (ER). These offices have mechanisms in place to incorporate industry input into their programmatic planning. The overwhelming majority of the R&D performed under programs in the offices of FE and CE is cost shared with industry: in FE for example, 90% of the research is contracted out, and industry provides 20-50% of the total cost of the research. FE and CE research is strongly focused toward supporting industry concerns.

The Geothermal Technology Organization (GTO), for example, consists of fifteen member companies and was formed to cost share geothermal research with the Geothermal Division of the Department. The GTO shares the cost of bringing specific new technologies in geothermal exploration, development and operation developed by the Geothermal Division to the field implementation stage. The 50% level of cost sharing is provided by two or more members of the GTO, to match the DOE contribution.

Defense Programs' Technology Commercialization Initiative plays an important role in DOE's Advanced Manufacturing Initiative (AMI), a new program which was established to facilitate the transfer of the special manufacturing expertise of the DP Labs and production facilities to the private sector. The National Center for Manufacturing Sciences, a group of over 100 manufacturers, has also agreed to collaborate with DOE in the area of advanced manufacturing, also providing direct industry contribution to DOE R&D.

The Office of Energy Research (ER) supports research of a more basic nature, which is usually not cost-shared with industry. There are, however, mechanisms to solicit industry input. For example, the National Laboratories have external review committees which draw scientific expertise from the industrial sector; Industry scientists are sometimes used in peer-review of R&D funding proposals; and, DOE-sponsored workshops to discuss future research needs also include industry participants.

ER's Laboratory technology transfer programs support several activities which directly involve industry input, including a new initiative for cost-shared Cooperative Research and Development Agreements (CRADA's). Technology research projects at the ER Laboratories have also been developed, including cost-shared personnel exchanges which bring researchers from industry to the Labs, and workshops with industry participants to develop technology transfer opportunities.

Thus, Industry input is an integral part of DOE's programmatic decision-making process, for both basic and more applied research.

Question 3(b). In the Secretary of Energy Notice you attached to your statement, it states on page two that the Department will "Increase the level of U.S.-based industry participation in the Department's research and development at all stages of program development and execution." But the Department currently seems to be advocating little industry participation at the execution stage and none at all at the program development stage. In fact, your statements indicating that no advisory panel or council should have a role in the Departments coordinating and planning activities would seem to contradict the Secretary's Notice. Could you elaborate on what the Department is doing to increase the level of industry participation at all stages, and how these efforts relate to your comments on this bill?

Answer. The Department strongly advocates industry participation at all stages of its research and development, wherever appropriate. The establishment of collaborative efforts between industry and the Department in the execution stage is emphasized in the National Energy Strategy. The Department's enhanced technology transfer activities, such as the Cooperative Research and Development Agreements (CRADA's), are directly targeted at increasing industry participation in the execution stage. It is, perhaps, more difficult to directly address industry participation in the program development stage. However, the Department does directly address the issue of industry participation in the program development stage by including strong industry involvement in its various scientific program advisory committees. The Department has Advisory Committees for almost all major programs and an Advisory Committee (Secretary of Energy Advisory Board, SEAB) for all of DOE. These committees are organized in a manner which includes industry representation. In addition, all of the Laboratories have advisory committees with industry representation.

In my written statement, my comments concerning the proper roles of an advisory committee were in reference to the roles assigned to the proposed Critical Technologies Council, is defined in Section 101 and other sections of S. 979. As currently drafted, this Council would have to be formed as an advisory committee; and thus S. 979 would create a situation in which contractor members of the advisory committee would have direct management authority over DOE and contractor activities. It is not a proper role of an advisory committee made up of outside parties to coordinate or otherwise directly manage Departmental or laboratory activities. As described above and in my testimony, we believe it is an appropriate, and crucial, role for such committees to assist in the planning of these activities.

REGARDING A DOE CRITICAL TECHNOLOGIES PLAN

Question 4(a). Admiral Barr testified in front of my Armed Services Subcommittee on May 7 with regard to the DOD/DOE Critical Technologies Plan. He stated that the process of developing the plan was "the first time that the laboratories have sat down together and tried to sketch out all the technologies that really contribute in an organized way and then pick out of those the areas that are critical" and that "it was an extremely beneficial exercise for us and I think it is going to pay big dividends for us and will be a very useful planning tool."

That report was focused only on technologies critical to national security funded by the Department's defense programs. We had thought that doing a similar plan that encompassed unclassified defense programs, energy research, and environmental restoration and waste management would also be useful. Could you explain why your view on this is so different from Admiral Barr's?

Answer. Admiral Barr and I do not disagree on the importance of planning. I also do not disagree with you concerning the need for effective, coordinated planning of DOE's unclassified research and development activities. The point I was trying to make in my testimony is that the development of a separate DOE critical technologies for DOE's unclassified activities is not necessary, since we have existing planning processes that accomplish the same purpose.

In fact, the Department has made a significant commitment to developing and implementing an integrated strategic planning and budgeting process for all of its unclassified research and development (R&D) activities. This process involves a series of planning steps, including the development of strategic and multi-year program plans, that ultimately result in an integrated R&D budget for the Department of Energy. This commitment, and the basic process, are documented in Secretary of Energy Notice SEN-25-90 entitled Strategic Planning Process, which was issued on July 24, 1990. A copy of which is attached.

The SEN established a requirement on Program Secretarial Officers, such as the Assistant Secretary for Defense Programs, to prepare Strategic Plans and Multi-Year Program Plans. We are in the process of preparing our first Internal Review Budget based upon the system established in the SEN. The integrated planning and budgeting process takes into account both the National Energy Strategy and the Complex Reconfiguration Study. This process has been established and has begun addressing unclassified research and development activities whether they are located in Defense Programs, Energy Research, or other authorized Departmental areas.

One of the important steps in the overall process is a program review process, during which DOE's unclassified programs are evaluated along a number of dimensions, including consideration of the potential impact on U.S. competitiveness as a result of a proposed R&D activity. The evaluation process includes a horizontal comparison of R&D activities across program lines, to ensure coordination between DOE's various program offices. The results of these evaluations are used by the Secretary to make decisions to increase, decrease, or maintain levels of support for specific programs in the annual budgeting process.

The planning activity undertaken by DOE's Office of Defense Programs (DP) in support of the DOD/DOE Critical Technologies Plan can be viewed as a first-of-a-kind planning activity for DP. DP, like DOD, has historically been a consumer of the research and development it supported. Thus, looking at these activities from the standpoint of U.S. competitiveness brought new insights into DP's planning process.

In contrast, DOE's basic scientific and applied energy research programs are designed to provide technology to universities and the private sector. Consequently, these programs have more experience at using "customer input" to establish funding priorities.

Question 4(b). You have stated that the Department supports research in nearly every critical technology identified. (A) How much is being spent on each technology identified by the National Critical Technologies Panel? (B) What are the goals and milestones for each? (C) Where is the work being done? (D) How does it relate to similar research being done in the private sector, other agencies, and colleges or universities? (E) If you do not have this information easily available, could you tell us why not, and why you oppose collecting it?

Answer:

Part (A). To answer this question we have attached (see Attachment A) an approximate cross-cut of the DOE FY 1992 budget request, organized according to the six major categories of the Report of the National Critical Technologies Panel.

A summary of the funding requests ($millions) from that budget cross-cut is shown below:

Critical technology category	*Funding request*	*Percent of total*
Materials	$371.2	13
Manufacturing	128.0	4
Information and Communication	118.9	4
Biotechnology and Life Sciences	159.4	5
Aeronautics and Surface Transportation	164.4	6
Energy and Environment	1994.7	68
Energy: 1076.0 (54%)		
Environment: 918.7 (46%)		
Total	$2936.6	100

Programs listed in this summary account for about 56% of DOE's non-Defense R&D budget. Not shown is $32 million in Defense Programs (much of which is in the area of advanced manufacturing) and $4.9 million in Energy Research programs, both for direct support of technology transfer. Also not shown is $18.9 million in administrative support (outreach, patents, licensing) of technology transfer in DOE Laboratories. As I mentioned in my oral comments, these technology transfer funds are designed to support increased laboratory collaboration with industry in any technology capability of the laboratories.

Summary program descriptions, listed by dollar amount and DOE organizational component, are provided in Attachment A.

As with any cross-cut, it was necessary to make a number of assumptions because a number of DOE programs fall into more than one category. For example, there are valid reasons to place "Transportation Materials R&D" under "Materials", or to place it under "Energy and Environment". Such ambiguity among categories is marked, for example, by "(ALSO 6)" to indicate that a technology might also fit in Category 6 (Energy and Environment).

The borderline between a "Critical Technology" and a closely related supporting technology is not always clear, and different definitions would give different results in this cross-cut. In case of doubt about whether to include a program in this list, our approach was to refer simultaneously to the DOE FY 1992 budget request and to the Report of the National Critical Technologies Panel, and to omit the program unless a clear reason could be advanced to include it.

Part (B). The programs summarized above constitute about 60 major programs, most of which in turn consist of a number of component programs. For example, DOE's entire Nuclear Reactor R&D program is included as a single item in a list of 27 other programs in the "Energy and Environment" category in Attachment A. Goals and milestones for these programs are available in the DOE FY 1992 budget request and in the program plans of the specific program offices, which, because of their volume, are not reproduced here.

Part (C). The type of organization doing work in critical technologies is roughly in proportion to the overall distribution of work done for DOE as a whole—about 65% in DOE Labs, about 5-10% in each of Federal intramural, industrial firms, and academic institutions, and a small remainder in non-profit institutions and State or local governments.

Part (D). The ways in which DOE's work in critical technologies relates to similar research in the private sector, other agencies, and colleges or universities is complex and multi-faceted. We know from experience that DOE researchers maintain wide-ranging contacts with other researchers in the private sector, other agencies, and academic institutions. The likely usefulness of DOE research-outputs for further development by others is often used as a criterion for project approval, but is not always reported as a data item. However this is becoming more of an explicit factor as a result of DOE's department-wide emphasis on technology transfer.

Part (E). DOE does not oppose collecting data on its R&D in critical technologies. We have a very large quantity of such data, however it is organized in a different format, using different criteria and definitions. Converting that data to a different format would involve establishing definitions as to what technology fell in what category, which is a time-consuming task. Establishing commonly accepted definitions is one of the critical tasks of the FCCSET interagency process. We are currently active in that process for biotechnology and advanced materials, and have completed it for high performance computing.

(Attachment A)

REPRESENTATIVE DOE WORK IN CRITICAL TECHNOLOGIES

(All dollars shown in millions)

Abbreviations used:

CE = Conservation and Renewable Energy
FE = Fossil Energy
ER = Energy Research
NE = Nuclear Energy
RW = Civilian Radioactive Waste Management
EM = Environmental Restoration and Waste Management
EN = Environment, Safety, and Health
IE = International Affairs and Energy Emergencies

Materials ($371.2)

CE: $23.0 Photovoltaic materials R&D (ALSO 6).

CE: $2.9 Materials manufacturing: high temperature chemical and laser deposition, microwave sintering of ceramics, non destructive evaluation of ceramics and metals.

CE: $5.2 Buildings and structures: aerogel superwindows, CFC (chlorinated fluorocarbon) substitutes, advanced optical/thermal coatings for windows.

CE: $16.7 Industrial waste utilization, conversion and minimization: scale up of biotechnology process to produce acetic acid from carbon monoxide and hydrogen emitted by carbon black plants (ALSO 4 and 6), industry pilot plant to increase silicon production while reducing silicon monoxide and carbon monoxide emissions (ALSO 6), test of UV (ultra-violet) cure dual coat technology to eliminate volatile organic compound emission (ALSO 6).

CE: $20.9 Materials processing: eliminate hot-rolling and reheating by single-wheel thin strip steel casting (ALSO 2), improve electrolysis processes, defect reduction in foundry casting, develop new light weight refractory fiber composites.

CE: $15.4 Enabling materials: processing and fabrication of continuous fiber ceramic composites, high temperature superconducting components, magnetic field processing in polymer manufacture, ordered intermetallic alloys, ultra crack-resistant ceramics, advanced ceramic coating technology such as coupled biomimetic growth and reaction sintering, virgin plastics that are more amenable to recycling, novel polymer systems, ceramic insulation to replace insulation using CFCs (ALSO 6).

CE: $23.8 Transportation Materials development (ALSO 5).

ER: $257.0 Materials sciences, basic research and materials synthesis in processing, electronic and photonic materials, ceramics, composites, high performance metals and alloys, superconductivity, and other materials related phenomena.

FE: $6.3 Development of advanced ceramics, new alloys, advanced austenitic steels and coatings, erosion and corrosion research, and technology transfer.

2. Manufacturing ($128.0)

CE: $4.9 Separations: design of sulfonated ion-exchange hollow fiber membrane for separations processes, design and test of black liquor pulsed combustion gasifier (ALSO 6), recover latent heat of evaporation in agricultural/food industry dryers, complete field testing of solid-on-solid processes for fabric printing and finishing.

CE: $2.4 Sensors and controls: develop on-line composition sensors for commercial magnesium cells (ALSO 3), Raman spectroscopy for distillation processes in chemical and refining industries, viscosity sensor for process control in Kraft pulping digester process.

CE: $6.9 Improved combustion efficiency: improve heat and mass transfer with pulsed combustion in industrial applications, initiate research on radiant burners, initiate research on gas recirculation for indirect load heating, initiate research on fluidized bed combustion, test supercritical wet oxidation units.

CE: $6.9 Process beating and cooling: heat pumps, recuperators, thermal science.

CE: $4.8 Expand Energy Analysis and Diagnostic (EADC) program to 22 participating centers.

ER: $92.6 Superconducting supercollider: design and manufacture prototypes of components, including superconducting magnets.

ER: $8.5 Isotope production: medical research, medical care, industrial research, agriculture, food preservation.

Information and Communications ($118.9)

ER: $10.9 Energy Sciences Network (ESNET).

ER: $93.0 Applied mathematical sciences (includes High Performance Computing and Communication project, as cross-cut from the High Performance Computing and Communications (HPCC) report).

ER: $15.0 Technical information management program.

4. Biotechnology and Life Sciences ($159.4)

CE: $5.0 Bioprocessing: research on synthetic biocatalysts, genetic engineering of algae or bacteria for production of chemicals, research on photobioreactors for chemical production.

ER: $90.9 Life sciences: structural, molecular, cellular, biology, genetic engineering, human genome research (robotized mapping technologies—ALSO 2).

ER: $33.9 Medical applications: radiopharmaceuticals, boron neutron capture therapy.

ER: $24.7 Energy biosciences.

FE: $4.9 Bioprocessing: recovery, conversion, and upgrading of coal, petroleum, and natural gas resources.

5. Aeronautics and Surface Transportation ($164.4)

CE: $4.3 Engine combustion processes: reduce octane requirement and reduce emissions in spark ignition engine design, R&D on two stroke engines to reduce size and weight, R&D on combustion of expected future fuel additives and blends, reduce soot end nitrogen oxide emissions from diesel engines.

CE: $16.0 Alternative fuels utilization.

CE: $16.5 Heat engine development.

CE: $41.6 Electric and hybrid propulsion development.

NE: $56.0 Space nuclear power systems

NE: $30.0 Space nuclear propulsion.

6. Energy and Environment ($1994.7)

Energy: ($1076.0)

CE: $1.8 District heating and cooling.

CE: $120.O Solar energy (biofuels also applies in category 4). Except photovoltaics shown under "Materials" (ALSO 1).

CE: $20.2 Geothermal Energy.

CE: $1.0 Hydropower.

CE: $30.8 Electric Energy Systems: electric field research, high temperature superconductivity (ALSO 1).

CE: $7.2 Energy Storage Systems: batteries, hydrogen research (includes batteries and fuel cells for transportation—ALSO 5).

CE: $12.9 Building systems research.

IE: $1.7 Emergency operations: communication links with States and other Federal agencies.
NE: $312.0 Nuclear energy R&D (excluding Space power and propulsion shown elsewhere).
ER: $35.8 Engineering and geosciences.
ER: $10.8 Advanced energy projects.
FE: $184.0 Coal, oil, and gas R&D, cooperative R&D, environmental restoration, and fuels programs.
FE: $315.0 Clean coal.
CE: $1.9 Solar building technologies.
CE: $6.9 Lighting and appliances.
CE: $10.7 Heating and cooling equipment for buildings
CE: $3.3 Cogeneration.

Environment ($918.7)
RW: $0.7 Civilian radioactive waste R&D.
FE: $1.0 Liquified gaseous spill test facility.
ER: $36.9 Environmental research.
ER: $36.6 Health effects.
EH: $46.5 Health physics and epidemiological research (partial listing/judgment call).
ER: $13.3 Analytic technology: radiation dosimetry, laser spectroscopy.
ER: $74.5 Carbon dioxide research (includes massively parallel computers and algorithms used in climate modeling—some portion possibly double counted from HPCC program ALSO 3)
ER: $20.3 Environmental research facilities operations.
ER: $158.0 Chemical Sciences (cuts across most other categories).
EM: $523.0 Environmental restoration and waste management (non-defense).
CE: $1.6 Indoor air quality.
CE: $6.3 Municipal solid waste.

Not included in this listing: Defense Programs, Power Marketing Administrations, high energy physics, most construction, most program direction, supporting analysis, and policy funding, most capital equipment, major user facilities, university and science education, laboratory facilities support, environmental activities related to inspection and compliance, Petroleum and Oil Shale reserves, Inspector General, Economic Regulatory Administration, $440.9 million of the SSC, RLA, and FERC.

The ER Fusion program is also omitted because it was excluded from the Critical Technologies Report, even though this program contains elements related to critical technologies such as superconducting magnets, radiofrequency heating, and supercomputers.

REGARDING DOE CRITICAL TECHNOLOGIES PLAN

Question 4(c). You have stated that developing a plan identifying this information "may be counterproductive to more effective management of the Nation's scientific and technological resources." Could you explain further on how this might be counterproductive, and how your statement relates to Admiral Barr's earlier statement that the process was "extremely beneficial" to the Department's defense programs? Could you also relate your views on this effort as "counterproductive" to the view of industry groups such as the Council on Competitiveness and the Aerospace Industries Association, who have been actively supporting the development of such plans?

Answer. Our primary objection to Section 103 of S. 979 is the requirement to create a separate R&D plan for critical technologies; not the need to have effective planning processes. The description of the proposed plan in Section 103 implies that support for critical technologies is somehow a separate mission of the Department of Energy, distinct from our other mission responsibilities. We believe this view is misleading. DOE's capabilities in critical technologies are a result of our other mission responsibilities, including basic scientific research, applied energy R&D, and weapons research and production. Through our technology transfer mission, we are responsible for seeing that the results of these activities are transferred to the private sector for commercial application. Under its authorizing legislation, DOE does not have a specific mission responsibility for the full range of critical technologies.

We believe it is "counterproductive to more effective management of the Nation's scientific and technological resources" to single out DOE to develop a separate Critical Technologies Plan. DOE is only one of several agencies with responsibilities related to the critical technologies identified by the Report of the National Critical Technologies Panel. DOE and other agencies participated actively in the development of that Report, as well as the DOD Militarily Critical Technologies Report.

Creating a separate report for DOE would be duplicative of those efforts, and could create further confusion in the eyes of the private sector, by creating yet another version of a critical technologies report.

The real issue in creating a more effective management structure is whether the findings of the existing critical technologies reports are integrated into the management processes used by Federal agencies, including DOE. As we indicated in both the written testimony on June 27, 1991, and in the answer to your Question 4a, DOE is working to integrate the findings of these reports, and many others, into our mainstream planning and budgeting processes. Further, we coordinate these activities with those of other agencies through a number of interagency working groups and committees.

Creating new and separate planning and coordination processes to create a Critical Technologies Plan would divert valuable time and resources away from the ongoing management processes of the Department. And, once this separate plan were complete, we would still need to integrate its findings into the Department's strategic planning and budgeting process. We believe it is more efficient and cost-effective to approach the planning for these critical technologies as a cross-cut to our primary mission responsibilities, as defined by DOE's existing planning and budgeting process. As such, there is no conflict between Admiral Barr's view of the benefits of a cross-cutting planning process and my comments concerning the plan itself.

Finally, the recommendations of the private sector, including the Council on Competitiveness, call for greater coordination across all Federal agencies.

We agree with that perspective and we believe that the processes described above and in my written testimony support those recommendations.

LAWRENCE BERKELEY LABORATORY,
Berkeley, CA, July 16, 1991.

Hon. WENDELL H. FORD,
Chairman, Subcommittee on Energy Research and Development, Senate Energy and Natural Resources Committee, Washington, DC.

DEAR SENATOR FORD: Thank you for your June 28, 1991 letter requesting the answer to followup questions from the June 27, 1991 hearing. It was a privilege to testify before the Subcommittee, and I look forward to assisting your efforts in support of DOE and its national laboratories.

Sincerely,

CHARLES V. SHANK,
Director.

[Enclosure.]

Question 1. Are the laboratories capable of carrying out research in all 22 of the technologies listed in the critical technologies report?

Answer. I believe that most, if not all, of the critical technology research areas are covered to some extent by the laboratories. Within the six broad categories of critical technologies established by the Panel, LBL has particular expertise in Materials, Manufacturing, Biotechnology and Life Sciences and Energy and Environment. The strengths of the other laboratories should be addressed by the Department.

Question 2. Should the laboratories be looking for new areas of technology to go into or more toward expanding on their existing areas of expertise?

Answer. The DOE multiprogram laboratories have, through their research programs, developed technical capabilities that could be specifically directed towards technology research areas. This additional work would expand and build on existing areas of scientific and technological expertise to benefit the advancement of critical technology research. A good example from my testimony is in nanostructure synthesis and processing, which takes advantage of LBL's traditional strengths in materials science and engineering.

Question 3. Do you believe that the current mechanisms you have available to you—Cooperative Research and Development Agreements, Work for Others, User-Facility Agreements—are adequate for the kind of work you would like to do with industry?

Answer. With the proviso that additional procedural flexibility would help make more effective use of these mechanisms, existing arrangements are sufficient for expanding industrial interactions at the national laboratories.

Question 4. Who usually initiates using Cooperative Research and Development Agreements—industry or the labs or both?

Answer. These relationships can be, and are, initiated by either party, and there is no set pattern one way or another. The relationship, however, is ultimately pulled together in the DOE CRADA process at the involved national laboratory.

Question 5. What exactly is generic, pre-competitive technology research?

Answer. Perhaps the best way to define this term is to examine its individual components. The term "generic" refers to technological developments that will affect a spectrum of areas, rather than one single product. The best example might be the development of the integrated circuit. "Precompetitive" refers to a stage in the research and development process where companies can work together in a scientific or technological field where the work is fundamental enough that specific product applications are not yet envisioned. "Technology research" focuses on the technological advances that can be based on scientific research. An example is the field of x-ray lithography, where technology research will focus on developing many of the technical components for focusing and delivering the x-rays to the semiconductor chip material.

Question 6. To what extent are the laboratories carrying out generic, precompetitive research as opposed to basic scientific research?

Answer. Because the Department of Energy, the principal sponsor of work at the multiprogram national laboratories, does not consider technology research to be part of its mission, it generally does not support technology research at its laboratories.

Question 7. What process should be put into place to decide the generic, precompetitive technologies to research?

Answer. The process that has worked well in the Department of Energy for funding scientific research proposals is to have them "peer reviewed" by scientists in that particular field from the other national laboratories and universities. With the additional of industrial research scientists, this same process could be used to decide which technology research programs to support. In addition, the criteria under which proposals are to be considered should take into account the National Critical Technologies Panel list and the technological competencies of the involved laboratories.

Question 8. Under current procedures, how does industry influence each of the laboratories' research and development agendas?

Answer. The level of industrial influence depends upon the type of program at the laboratory. For some fundamental scientific areas, such as high energy and nuclear physics, there is little industrial involvement in setting the program direction. In other programs where there is more industrial interest and application, there are varying levels of involvement. For example, LBL's Center for Advanced Materials, dedicated to working on materials research questions of direct industrial interest, has an advisory board for each of its programs that is primarily composed of industrial scientists. Another example is LBL's California Institute for Energy Efficiency, working on energy-efficiency questions of particular interest to California. The Institute's advisory board is composed mostly of representatives from the California utilities that provide most of its funding.

Question 9. Should we create some sort of industrial advisory body for each of the laboratories?

Answer. Most, if not all, of the DOE national laboratories have high-level advisory committees with industrial representation. In addition, most of the laboratory divisions and major programs also have advisory boards with industrial members. A separate industrial advisory board may not be the most effective strategy. Integrating advice from industry into the overall advice given the laboratory will have the strongest effect on setting the overall direction of the laboratory.

ALLIED SIGNAL, INC.,
CHEMICAL AND PROCESS TECHNOLOGY,
Des Plaines, IL, July 12, 1991.

Hon. WENDELL H. FORD,
Chairman, Subcommittee on Energy Research and Development, U.S. Senate, Committee on Energy and Natural Resources, Washington, DC.

DEAR MR. FORD: Per your request, attached is my response to questions to be included in the printed hearing record of the Subcommittee on Energy Research and Development on S. 979, the "Department of Energy Critical Technologies of 1991" hearing record.

If you should have any questions or require any further information, contact me at your convenience.

Sincerely,

ALAN D. WILKS,
Vice President.

[Attachment.]

Question 1. Should the Department's national laboratories venture out into new areas of technology or simply build on existing areas of expertise?

Answer. The national laboratories should venture into new areas of technology, which will take advantage of and build on their capabilities and expertise. Where appropriate, there may be new areas that develop. New materials are an example of where there is new knowledge, technologies, and processes that could be developed at the laboratories. This has occurred in structural ceramics and high temperature superconductivity. The laboratories in-house efforts, however, should be limited to basic research and exploratory development (6.1 and 6.2 in the DOD terminology) and not into component development and larger scale experimentation, prototyping scale up, and commercialization. It is also appropriate to combine in-house research activities with program management of government funded industry efforts, which might entail component development and scale up by industry.

Question 2. How well are the Cooperative Research and Development Agreements Working?

Answer. The process for identifying technical areas of mutual interest between a national laboratory and industry for a CRADA is working smoothly as is the issuance of a request for proposal and review of proposals. The proposals are not burdensome. The review process has been quick and the timetable from issuance of request for proposal to notification of selection for negotiation has occurred in less than 3 months. The negotiations of terms and conditions, however, have taken more than 6 months. These need to be more flexible and streamlined. Current CRADA's are written as if the participant (industry) is entering into a funded contract, which it is not. As an example, consider audit rights since there is not a dollar exchange, there should be no audit rights expected. Signing the agreement (CRADA) commits the participant to the statement of work and estimated share of cost. Audit clauses should be eliminated. Time periods for proprietary information and patent filings should be lengthened for the participant. CRADA's are a relatively new instrument and it is hoped that terms and conditions for proprietary work will be reduced and more flexibility given as government gains experience with them.

Question 3. Dr. Owczarski testified that industry should drive the laboratories research and development agenda. The National Association for Manufacturing recommends industry research advisory councils. Are such advisory councils the way for industry to drive the process? If so, how would they be set up and exactly who would they advise?

Answer. Industry should not "drive the laboratories R&D agenda," but should have input to it. Laboratories need to address the needs of industry, but the laboratories also need the flexibility to focus not only on short term problems, but also longer term areas, which is an appropriate role for the government to support. The difficult issue here will be a tendency to address those issues which industry is better equipped and positioned to do for itself. Input can be obtained by visits between the laboratories and industry at both locations, but for the interaction to proceed there needs to be a clear understanding of the mutual benefit to both participants. Laboratories already have advisory panels on which industry is represented. The laboratories can discuss their programs at industry association meetings. This has occurred successfully at USACA meetings.

Question 4. Could the Department and the laboratories do a better job of making industry more aware of the resources and equipment available at the labs?

Answer. Yes. Some of the laboratories are more proactive and effective than others. I am aware that Oak Ridge National Laboratory (ORNL) has done an excellent job in making industry and universities aware of the High Temperature Materials Laboratory user facility and has apparently streamlined the process for proposals and agreements. ORNL, Argonne National Laboratory and Los Alamos National Laboratory have done a very good job with the High Temperature Superconductivity Pilot Centers. There has been management support throughout these three laboratories for technology transfer activities. I have been told that the Secretary of Energy has recently issued a notice to the laboratories that technology transfer activities are an important mission for the laboratory and it will be an evaluation factor in the performance of their contracts. Facilitation of the use of user facilities for proprietary activities by industry would enhance the utilization of these resources (see comments on question 7).

Question 5. At what point should we draw the line at the kind of work the laboratories are doing because to cross that line would interfere with the work industry should be doing by itself?

Answer. The laboratories should conduct research which is broadly beneficial to U.S. industry and not just one company unless that company has specifically contracted for and fully supported such activities financially. The laboratories should not perform scale-up or commercialization activities on their own initiative. Such activities in support of an industry driven and funded initiative may on the other hand be totally appropriate.

Question 6. Dr. Shank mentioned that the Department's laboratories should support generic, pre-competitive technologies. What do you view generic, pre-competitive technologies as?

Answer. Generic, precompetitive technologies include activities to lead toward the understanding of the relationship between process, properties and structure of materials. Development and understanding of new or alternative ceramic processing technologies such as microwave sintering, gel casting, joining techniques; development of ordered intermetallics; and development of computational-experimental techniques such as the Materials-By-Design approach, are all additional examples.

Question 7. Do you believe that the current mechanisms the Department uses to work with industry—the Cooperative Research and Development Agreements, Work for Others, User Facility Agreements—are adequate for the kind of work you do or might want to do with the laboratories?

Answer. The mechanisms plus the ability to subcontract with industry are adequate instruments for most activities. Flexibility and streamlined approval processes need to be applied wherever possible as mentioned in response to question two. A particularly troublesome area is the use of National Laboratory User Facilities for work of high and proprietary value to industry. There continues to be a movement towards a mutually acceptable working agreement but roadblocks which prevent the facile application of these powerful tools to the solution of the most appropriate problems seems to me to be not in the best interests of any of the concerned parties or the nation.

National Association of Manufacturers,
International Economic Affairs,
Washington, DC, July 11, 1991.

Hon. Wendell H. Ford,
Chairman, Subcommittee on Energy Research and Development, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

Dear Mr. Chairman: On behalf of United Technologies Corporation and the National Association of Manufacturers, I want to thank you for the opportunity to testify on S. 979, the "Department of Energy Critical Technologies of 1991," on June 27. In addition to the issues raised in the hearing, you posed seven additional questions, for which I am pleased to submit the following comments.

I hope these comments are useful and look forward to continuing to work with you and the Subcommittee on these important issues. If I can be of any additional assistance, please feel free to call upon me, United Technologies or the NAM at any time.

William A. Owczarski.

[Enclosure.]

Question 1. Should the department's national laboratories venture out into new areas of technology or simply build on existing areas of expertise?

Answer. In general, the laboratories should stick to their existing areas of expertise—their "core competencies." Diverting lab resources into technical areas unfamiliar to them or sending them off on "me-too" research projects would not be a wise use of lab assets.

This general rule should not, however, become a straightjacket. In technology, the only constant is change, and flexibility is a critical ingredient to managing change successfully.

Question 2. How well are the cooperative research and development agreements working?

Answer. Given the recent existence of CRADAs and the small number (fewer than 25) of them actually under way, it is much too early to gauge their success. As a general observation, it is likely that the CRADA structure will require periodic adjustment—as would any new practice.

Question 3. Dr. Owczarski testified that industry should drive the laboratories' research and development agendas. The National Association of Manufacturers recommends industry research advisory councils. Are such advisory councils the way for industry to drive the process? If so, how would they be set up and exactly who would they advise?

Answer. To say that "industry should drive" DoE lab R&D is perhaps too strong a statement. What would better serve the labs, industry and the nation is for industry to have a greater say in the direction the labs should take. No one expects the national labs to become subsidiary industry R&D facilities. The national labs should always have a broader, national purpose to their taxpayer-supported existence. To the extent that industry can guide the labs' R&D agendas towards those dual-use areas relevant to industry's needs, however, so much the better. The synergies that could be expected from closer lab-industry relations would greatly increase—for everyone—the return on the national investment in the labs.

The establishment of advisory councils is but one way of institutionalizing greater industry involvement into the labs R&D agenda-setting process. There may well be other, more effective ways to accomplish this. If so, we would likely support those mechanisms as well. Also, our use of the term "advisory" is a deliberate one: The labs should seek advice and guidance from these councils, not be managed by them.

If, as expected, the labs' traditional (i.e., strictly national security) mission orientation continues to wane, there will be a strong incentive for the lab directors to listen more carefully to their potential industry "customers." The idea behind advisory councils is to bring the labs into closer contact with these would be customers. Therefore, the structure of the advisory councils must be a decentralized one, so that each laboratory would--if it so chose—have its own council.

Although we have not considered in detail how such councils could be set up, we would advocate the simplest approach. The President or Secretary of Energy may already possess the authority to sanction creation of advisory councils. If not, then legislation may be necessary. Whatever the mechanism of their establishment, it is important to avoid bureaucratizing the advisory process to the point where it becomes useless or even counter-productive.

Question 4. Could the department and the laboratories do a better job of making industry more aware of the resources and equipment available at the labs?

Answer. Yes, and industry could and must do a better job of searching out this information. Suggested ways to do this can be found among NAM's recommendations regarding the federal laboratory system (which are appended to my June 27 testimony).

Question 5. At what point should we draw the line at the kind of work the laboratories are doing because to cross that line would interfere with the work industry should be doing by itself?

Answer. The drawing of a "bright line" is probably not feasible nor helpful. There are, however, factors that will naturally limit the labs' activities, thus obviating the need for any bright line.

One of U.S. industry's single biggest problems with technology is its commercialization. Given industry's own difficulties in overcoming this problem, it is highly unlikely for the private sector to turn to the labs—which have absolutely no history, experience or expertise in this arena—for help in solving the commercialization puzzle. This would appear to be a natural boundary over which the labs could not cross.

There are also other factors that should make a formal bright line unnecessary. For example, the strengths of the labs—facilities in particular—are most useful to industry in the "pre-competitive" stage of technology development. This is the stage at which industry has historically under-invested, because the resulting knowledge is less proprietary and too far removed from commercialization for any one firm to justify.

Finally, we would suggest something that these days may be regarded as hopelessly naive (or heretical): good old common sense and trust. We proceed from the assumption that the Secretary of Energy, the laboratory managers and workers, and those from industry are cognizant of the simple fact that it is to no one's advantage to get the labs involved in activities that industry should be doing.

Question 6. Dr. Shank mentioned that the department's laboratories should support generic, pre-competitive technologies. What do you view generic, pre-competitive technologies as?

Answer. Officially, we would agree to the definitions established by statute, such as that found in 15 CFR part 295 (as authorized by 15 USC 271 et seq and section

5131 of P.L. 100-418, 102 Stat. 1439, 15 USC 278n). Other terms, such as "defense critical technologies" and "national critical technologies" (section 841 of P.L. 101-189), "emerging technology" (the Commerce Department's 1990 Emerging Technologies report), "enabling technology" (OSTP's U.S. Technology Policy statement) are also reasonable and generally agreed-upon definitions. Less officially, though perhaps more realistically, we would also agree that precise definitions may be impossible. Here, the proper analogy is to be found in the jurist who, in a situation involving obscenity, found it difficult to define yet knew it when he saw it.

Question 7. Do you believe that the current mechanisms the department uses to work with industry—the cooperative research and development agreements, work for others, user-facility agreements—are adequate for the kind of work you do or might want to do with the laboratories?

Answer. As indicated in response to question 2 above, there is always room for improvement in these types of arrangements. Beyond the items suggested in our "Technology Policy Recommendations," we have no specific recommendations for change at present.

There is, however, one other point worth noting. More important than the mechanisms themselves is the change in culture that is necessary for closer lab-industry cooperation. Neither side has much experience in working with the other, and ingrained habits are hard to break. Incentives toward breaking down these barriers should be encouraged.

SANDIA NATIONAL LABORATORIES,
Albuquerque, NM, July 11, 1991.

Hon. WENDELL H. FORD,
Chairman, Subcommittee on Energy Research and Development, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

DEAR SENATOR FORD: Thanks again for the opportunity to testify on June 27, 1991 on the subject of Senate Bill 979, "Department of Energy Critical Technologies of 1991". It was a privilege for me to share my views with you and other members of the Committee.

I am enclosing responses to the supplementary questions which you sent in your letter of June 28. I trust this response addresses the areas of interest which could not be covered fully during the hearing. If I can be of further assistance, please contact me.

Sincerely,

A. NARATH,
President.

[Enclosure.]

Question 1. Are the laboratories capable of carrying out research in all 22 of the technologies listed in the critical technologies report?

Answer. In aggregate, the core competencies of the DOE laboratories cover many of the 22 technologies listed in the critical technologies report. Whether or not that coverage is complete would be a matter for DOE comment. At Sandia National Laboratories, our core competencies include several of the critical technologies-advanced materials, manufacturing, microelectronics and photonics, for example—but not the entire list of 22.

Question 2. Should the laboratories be looking for new areas of technology to go into or more toward expanding on their existing areas of expertise?

Answer. The laboratories have developed their existing core competencies as required to address their core missions. As a result, they represent a technological resource which the Nation can apply to other urgent national needs without the necessity of building a new core competency from a zero base. If now areas of technological competency are required of the laboratories to meet national needs that cannot be met by other means, then perhaps the investment that would be required to develop them would be justified. I do not believe, however, that the laboratories should be looking for new areas of technology to go into unless the needs of the Nation demand it.

Question 3. Do you believe that the current mechanisms you have available to you—Cooperative Research and Development Agreements, Work for Others, User-Facility Agreements—are adequate for the kind of work you would like to do with industry?

Answer. The new mechanism in the list—Cooperative Research and Development Agreements (CRADA)—is, at this time, still untested. The intent of the NCTTA of 1989 which enabled us to participate in CRADAs was to answer industry's need or speed, flexibility and certainty in the development of CRADA partnerships. We do not yet know what the practical limits of the CRADA process will be or whether in their present form, CRADAs will meet industry needs. Because we are still learning what can be done with CRADAs, my response is that the mechanisms we have available are currently adequate. As we learn how to use them better, we may also learn more about their limitations.

Question 4. Who usually initiates using Cooperative Research and Development Agreements—industry or the labs or both?

Answer. Both industry and the labs are usually involved in initiating discussions that will lead to CRADAs. We at the labs know the technical work at our lab which has the potential for commercialization, so we are often in a position to make first contact with a segment of industry which might be interested in further cooperative development. On the other hand, industry knows the needs of the marketplace. That means that industrial concerns often make first contact based on their need for technical solutions to marketplace problems. In both cases, there must be something of substance on each side of the table—real technical solutions at the labs and real marketplace needs in industry.

Question 5. What exactly is generic, pre-competitive technology research?

Answer. Generic, pre-competitive research is research consistent with the following two guidelines: (1) it is generic in that it aims to develop techniques, processes, or principles that can be applied to many specific needs and (2) it is pre-competitive in that it addresses questions of feasibility or practicality that govern an entire class of competitive products and that do not compromise potential competitive advantage. It may be best to illustrate with examples. Our work in the technology of chemometrics is generic in that it can be applied to a wide range of specific needs in the area of materials and process design. Our work in diagnostic instrumentation for remelt furnaces is pre-competitive in that it can be applied to many different furnace designs, conferring on every design an advantage compared to furnaces without diagnostics, but in no way diluting or magnifying the existing competitive differences between the designs.

Question 6. To what extent are the laboratories carrying out generic, pre-competitive research compared to basic scientific research?

Answer. Basic scientific research is largely carried out in universities and research labs such as the Stanford Linear Accelerator Lab or the Fermi Lab. Sandia is primarily an applied research lab that focuses on providing solutions to applied problems. We have always sought to balance our core mission programs so that our development engineering rests upon and flows from a solid research base. This approach continues to guide our research priorities. As the need for more dual use or multiple use research and development has become evident, we have looked to universities and research labs for basic research input and our industry partners to help us refine our prioritization without losing the balance that we need for the core competencies that sustain our nuclear mission. That means that our trend is toward more generic, pre-competitive research that can forge stronger industry ties and move more lab technology into industry. At the same time, we are managing that shift so that our capability to carry out our core mission is enhanced rather than weakened.

Question 7. What process should be put into place to decide the generic, pre-competitive technologies to research?

Answer. Perhaps I can best address this question by sharing with you some of the steps we are taking to improve our capability at Sandia for making such decisions. Since our laboratory has always been operated by AT&T, we have from the beginning benefited from input at all levels from that industry leader. Because of this long-term relationship, our business management practices as well as our approach to selecting technical areas of potential interest to industry have been influenced by the experience and vision of our parent company. In addition to this intimate form of industry input, we receive frequent inputs from industry suppliers and program partners that help us gauge what generic, pre-competitive research choices will best support our programmatic needs while at the same time addressing the potential needs of U.S. industry. We have formed an industry panel to provide market guidance in our technology transfer activities and are also forming a President's Advisory Panel which will consist of industry representatives whose input will further influence our management decisions.

Question 8. Under current procedures, how does industry influence each of the laboratories' research and development agendas?

Answer. In addition to the industry panels mentioned in the answer to the last question, our technology transfer mission now to include technology transfer. This mission has been communicated to every level of staff and management in the laboratory. In every interaction with industrial entities, whether small business suppliers or sponsors in Work for Others programs, our staff and management are seeking industry input on how our work can be made more relevant to industry without compromising our commitment to meeting the needs of our customers in DOE or other agencies. It is our policy to seek this input across the board. The procedures that implement this policy vary according to the nature of our relationship with a particular industry contact and with the requirements of the program involved.

Question 9. Should we create some sort of industry advisory board for each of the laboratories?

Answer. We believe the steps already taken at Sandia are appropriate.

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